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(ESTABLISHED IN 1832.)

THE OLDEST RAILROAD PAPER IN THE WORLD.

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EDITORIAL NOTES.

THE *Paris* has now suffered from two accidents, in each of which the value of the twin screw has been demonstrated. In the last accident, wherein the rudder was disabled, the remarkable feat of navigating a vessel for 500 miles, a part of it in heavy weather, by means of the screws alone was accomplished. To any one who has attempted to steer a vessel in a heavy sea, and knows the constant vigilance and work at the wheel which is required, the fine adjustment of speeds of the screws, and the constant variation of the same that would be required, makes the work done on this trip out from Southampton and return seem a little short of the marvelous.

WHEN the *El Cid*, now the *Nictheroy*, was purchased and sent south to help quell the Brazilian rebellion, it was expected that she would do a vast amount of work in settling some questions that have been vexing the spirit of naval experts for many years. There was the dynamite gun, located forward to prove its efficiency or worthlessness; but as far as we can learn, not a shot has been fired, and the gun might as well be in New York as in Brazilian waters. Then there was the fast unarmored cruiser pitted against powerful battleships. Which wins? No fight, no shooting, and problem still unsolved. Our nature is not naturally bloodthirsty, but we feel that the dynamite gun as a fighting mechanism has never had a chance to show its worth or worthlessness, and in the interests of mechanical science we would like to know what can be really expected or feared from such a vessel as the *Nictheroy* now is.

LAST July we made the remark, in commenting on the discussion by the Association of Master Mechanics on the compound locomotive, that from the mass of contradictory testimony it was difficult for an unprejudiced observer to tell "where he was at." We would call attention to two reports from widely different sections of the country, published in other columns of this issue, which go to show that a very decided saving of fuel is effected by the compound. This seems to be assured, but the unprejudiced observer is still looking for data regarding expense for repairs, and on this point information seems to be difficult to procure. There seems to be no good reason why a well-designed compound should be more expensive to maintain than a single engine, except in the matter of the larger cylinder; but the very fact that they are new, that none has ever worn out, and that repair records are not published serves as a check upon their introduction.

MEETINGS OF MEMBERS OF THE SOCIETY OF MECHANICAL ENGINEERS.

THE second meeting of the series, which has been inaugurated this winter, was held in the hall of the Society on the evening of February 14. The subject for discussion at the first meeting—"The Development of Stationary Engines, as illustrated by those exhibited at the Columbian Exhibition in Chicago"—was continued. Professor John E. Sweet, of Syracuse, read an introductory address, which will be found on another page, with an abstract of the discussion which followed. There were about 80 members present.

The two meetings which have been held, under the auspices of a committee appointed at a meeting of members held last November, have been very promising of success to the scheme. When they were first proposed objection was made to having these meetings of the Society, on the ground that few non-resident members could attend them. It was somewhat of a dog-in-the-manger argument, but was regarded by those who wanted to hold such meetings. They claimed the right of coming together in the rooms of the Society and discussing any subject they chose, and therefore the meetings were called as meetings of members of the Society merely, and not meetings of the Society itself. Now, however, fault is found by a correspondent in the *Railroad Gazette*, that the Society does not publish the proceedings, and he claims that the non-resident members have a right to them, and are deprived of what they may reasonably expect to get. It may be said here that a reporter has been employed to make verbatim reports of the discussions, and that any newspaper or other party can have copies of these reports by sharing its or his proportion of the expense. THE AMERICAN ENGINEER, the *American Machinist* and *Engineering News* are the only papers which have thus far agreed to enter into this arrangement.

The next meeting will be held on Wednesday evening, March 14. The subject for that evening will be "*Testing Machines and Tests of Materials.*" The introductory address will be by Mr. J. Sellers Bancroft, of Philadelphia, who will describe the recent improvements which have been made in the Emery system of testing machines.

Members have the privilege of inviting friends, and it is proposed to issue blank cards of invitation to the members which can be used as they see fit. The next meeting promises to be of great interest to all who are concerned in the tests or testing of materials used in engineering.

THE LIMIT OF INTELLECTUAL ELASTICITY OF AN AVERAGE AUDIENCE.

IN Balfour Stewart's admirable "Lessons in Elementary Physics" he says: "There is a limit within which a body may be temporarily acted upon with the certainty of its recovering its figure when the force is withdrawn, and this limit is called the *limit of elasticity*, the word *elasticity* denoting tendency to recovery. When this limit is overpassed the body does not recover itself, but becomes weaker and weaker, until at length it yields to the applied pressure."

Some intellectual phenomena seem to be controlled by an analogous law. Our minds may be subjected to a given amount of tension, not exceeding a certain limit, with the certainty of recovering their original attitude ; but if taxed beyond this limit, our attention becomes weakened until finally apprehension fails, and "the subsequent proceedings interest us no more."

The existence of a physical limit of elasticity in solid bodies may be proved from certain phenomena which occur when such bodies are subjected to tension. In a similar way we may study the intellectual phenomena which are manifested when an audience is "acted upon," and the minds of those who compose it are in a state of more or less tension, and we may thus deduce some of the laws which control the mental operation of an assemblage of people.

But, as some logician has asked, "On what principle do we decide, in watching a succession of phenomena, that they are connected as cause and effect, that one happened in consequence of the happening of another ?" In the present instance we may adopt John Stuart Mill's statement of the principle which may be adopted in an investigation of this kind. This statement he calls the "canon of the method of difference," and it is as follows :

"If an instance in which the phenomenon under investigation occurs, and an instance in which it does not occur, have every circumstance in common save one, that one occurring only in the former, the circumstance in which alone the two instances differ is the cause, or an indispensable part of the cause, of the phenomenon."

To apply this method in determining whether an ordinary assemblage of people has any intellectual limit of elasticity, we need "an instance" in which a body of people is subjected to a limited degree of mental tension, repeated many times, and from which they always regain what—to use Balfour Stewart's physical phraseology—we may call the "figure" of their minds.

Then we need another instance in which the limited degree of mental strain referred to is "overpassed," and from the repetition of which the audience does not recover, but its attention becomes weaker and weaker, until at length it fails altogether to apprehend the discourse to which it is subjected.

Happily for our hypothesis and for our investigation, we have two such instances. The one was anticipated by a notice dated February 5, in which it was said that

"The second meeting of Members of the Society of Mechanical Engineers for the discussion of subjects pertaining to their occupations will be held in the hall of the Society, at No. 12 West Thirty-first Street, New York, on Wednesday evening, February 14, at 8 P.M. The subject which was discussed on January 10—'the DEVELOPMENT OF STATIONARY ENGINES, as illustrated by those exhibited at the Columbian Exhibition in Chicago'—will be continued at the next meeting. The introductory address will be by Mr. John E. Sweet, of Syracuse, N. Y. The subject will then be open to general discussion."

The other was announced as follows :

"The next meeting of the New York Railroad Club will be held at 12 West Thirty-first Street, on Thursday evening, February 15, 1894. Mr. R. A. Parke will read a paper entitled 'The Vertical Influence of Counterbalancing' (on locomotives). There will be proofs of the text and illustrations for distribution among members present."

The introductory address of Professor Sweet, which was read at the meeting of Mechanical Engineers, will be found on another page, with part of the discussion thereon. The other paper on Counterbalancing, owing to the limited space available in THE AMERICAN ENGINEER, the hard times, the heavy expense of setting up a great many abstruse mathematical formulæ, and for other reasons has not been republished, nor would our readers probably be much interested in the discussion which followed the paper. The two meetings, however, supplied the instances which Mill says are needed to determine that the succession of phenomena, which were manifested, were connected as cause and effect—that is, the two meetings "had every circumstance in common save one," and the phenomenon under consideration occurred at the one meeting, and did not occur at the other. Or, to express it differently, the audience in the one case was acted upon by intellectual forces repeated temporarily many times, and in each case it recovered its "figure," and, apparently, when the discussion was ended the apprehensive capacity of the audience was as great as when the meeting began. On the second evening, however, it was obvious that the elasticity or "the tendency to recovery" of the attentions of those present was "overpassed." As already remarked, the two meetings "had every circumstance in common save one"—that was the character of the papers. Our readers may judge of Professor Sweet's paper themselves—probably few of them will begin reading it without finishing it at one sitting. It is clear and incisive, with veins of humor running through it like the striations in a crystal. There is not a dull or obscure line in the whole of it, and it has pre-eminently the merit of lucidity. When he ended the reading of it there was a general manifestation of resilient satisfaction through the whole audience. Each individual seemed to recover his mental spring the moment the professor relieved the gentle and agreeable strain on their attention.

It may be said of an audience as Mr. Clark—in his work on the Britannia and Conway tubular bridges—said of girders, that "time is an important element in producing the ultimate permanent set in any elastic material." In all the wrought-iron girders which he tested, he says that "a considerable time elapsed before they attained a deflection which remained constant." That this principle is a law of intellectual as well as physical statics was recognized by the Committee which has charge of the meetings of the Members of the Society of Mechanical Engineers, in the rule which has been adopted by them, requesting the principal speaker of each evening not to occupy more than 30 minutes, and limiting those who take part in the discussion thereafter to five minutes. For such periods of time an audience will have the power of resisting a degree of strain without deformation, which, if imposed for longer periods, would result in an enduring stretch, which may be manifested by frequent yawning and lateral deflections. At the meeting referred to, the demands made upon the attention of the audience were much below the elastic limit, both in the introductory address and in the discussion which followed. When the meeting ended the audience seemed to rebound, and was in an alert and even jovial state of mind. All were apparently interested and entertained, some were instructed, and probably others will ultimately be pecuniarily profited by reason of being present. Many of those who were there congratulated others who were present on the fact that there had been "a good meeting." As these meetings are to a considerable extent experimental—the one referred to being only the second one of the series—the interest which was manifested was especially gratifying to those who, in a measure, are responsible for them and for the manner in which they are conducted. That the attention of the audience was not stretched beyond its intellectual elastic limit was, however, obvious, and was due to a very considerable degree, if not entirely, to the fact that those who took part in it recognized that "a listener has at each moment but a limited amount of mental power available, and it is of the utmost importance that this attention should be economized, and that ideas should be presented so that they may be apprehended with the least possible mental effort."

As a contrast to this meeting, the one held on February 15

may be quoted. The paper which was then read occupied 30 pages of closely printed minion type, interspersed from beginning to end with mathematical formula, of a high degree of tensile strength, or, to use a more expressive synonym, they were *tough*. It would be a very useful investigation, and it might help in the advancement of science and general engineering knowledge, if some one would make a series of tests of the capacity of resistance of an audience to mathematical strain, and would tabulate the results, or would plot them in a graphical diagram. The investigation might be conducted somewhat in this way: the investigator would prepare a series of mathematical demonstrations of a progressive character, beginning with examples in the simple rules of arithmetic, and progressing gradually to increasingly difficult problems followed by algebraic formulæ arranged in similar order, which could be succeeded by demonstrations and elucidations in which trigonometry, calculus and other tenacious mathematical methods are employed. The "sums," formulæ and demonstrations to be numbered, and each person in the audience to be provided with a card, and after the mathematical elucidation has been inscribed on a blackboard and explained, each person to mark on his card whether he comprehended the demonstration fully, partially, or not at all. From these cards a series of what may be called moduli of comprehension could be established. That is, they would show how many persons in an audience could understand simple arithmetical proof of any proposition, how many would go wool-gathering over decimal or vulgar fractions, the proportion of people to whom algebra is as Greek is to all who know but one language and are not Grecians. It would, we feel sure, be demonstrated that only an infinitesimal number of persons in audiences, like those which assembled in the hall of the Mechanical Engineers on February 14 and 15, can comprehend an elucidation, in which the processes of calculus are employed, by merely hearing it read. If different scientific organizations would make such tests and establish what might be called *factors of intelligence*, they would be a great help to those who contemplate reading papers before them in determining the limit of elasticity of the audience before which they are to appear. If, for example, it was found that 90 per cent. of the persons who are members of the Society of Mechanical Engineers can understand arithmetical demonstrations, 60 can go as far as easy algebra, 40 per cent. cannot follow in trigonometry, and only 10 can keep up when an author plunges into calculus, then, obviously, the character of his paper should be determined by the number of people he desires to interest and instruct. If it is his purpose to interest his whole audience, he will, if he is wise, do as Professor Sweet did—leave out all mathematics. If he is willing to ignore the 10 per cent. who cannot follow in arithmetic, he may put a few figures in his paper, or he may disregard the 40 per cent. who are "stumped" by algebra and risk a few or many formulæ. This train of reasoning will lead inevitably to the conclusion, that with a given audience a paper may have so much mathematics in it that it would not be worth while to read it at all, because so few or none could understand it. It would be somewhat like the aphorism of the young artist in *Punch*, who painted high-art pictures which no one would buy, and was asked by his uncle why he did not paint popular pictures, like the "Derby Day." The answer was that "art is for the few; the higher the art, the fewer the few; ultimately the highest art is for but *one*, and I am that ONE." There are papers which are evidently written for but one, and that *one* is the author. The question arises whether it is worth while to read such papers. They may have their use and be of very great value, but the reading of them before a miscellaneous audience is probably of no benefit to any one. It is safe to say that there were not three persons in the audience who listened to the paper which was read at the Railroad Club on the evening of February 15, or had the fortitude to hear it all, who could follow the reasoning or the demonstrations which the author had elaborated, evidently with much care and thought. The limit of elasticity of that audience was exceeded, and all who remained through the whole reading of it had a permanent mental "set," and their minds were stretched to such an extent that very few of them reacted when the tension was released. In a recent magazine article the author advises the jocular story-teller, before telling a story, always to calmly put to himself the question, "Should I —— A—— derive pleasure from listening to this from the mouth of B——?" Authors of papers to be read before miscellaneous audiences should always subject themselves to a similar introspection, and should solemnly ask themselves the question, "Would I, the author, be interested or profited from hearing a paper of this kind and length from B—— or any other person of equal caliber to myself?" It might not be a bad plan for committees in charge of such meetings to put some such question to the authors of papers before they are read.

It would, of course, be very great folly, at the present day, for any one to underestimate the uses and value of mathematics as an instrumentality for analysis and investigation. The projector of the North River Tunnel, who testified some years ago before a commission that he thought "a knowledge of mathematics dwarfed a man's mind," has, it is true, a counterpart in a venerable protectionist in Philadelphia, who in a recent public letter expressed the opinion "that of all the institutions in the country, the college was the one which exerted the most pernicious influence."

We all recognize the uses and value of mathematics, the regret of some of us being that we know so little; but a knowledge of it is somewhat like one's underclothing—useful and indispensable, but it is not well to display it publicly.

There are few engineers worthy of the name who would build a bridge, a roof, or construct a machine without taking into account the elastic limit of the material used, and who will yet appear before an assemblage of people without giving a thought to the fact that the attention of those who listen to them is limited by laws as absolute as those which govern the strength and resistance of iron and steel.

Of the value of the paper, whose form, character and length has been commented on, we will for the present at least have nothing to say. Some one has said that they always distrust a conclusion which cannot be proved in any other way excepting by mathematics. There is some reason for this distrust. Whether the conclusions which were reached by Mr. Parke are sound or not will not now be discussed. All that is intended here is to point out that such papers are unsuited for reading before audiences of the kind that assemble at the monthly meetings of the Railroad Club—and perhaps it would not be far wrong to say, or any other audiences—unless it be a very few who are well up in mathematics and are constantly using it. It would seem as though a short catechism might be framed which would be useful to those in charge of and those who intend to read papers or make addresses at technical and other meetings. It might embrace such questions as the following:

Is there a limit within which an audience "may be temporarily acted upon with the certainty of recovering its figure"?

When this limit is "overpassed," what happens?

What proportion of the audience will probably understand and follow an arithmetical demonstration by merely hearing it read? how many can keep up with the algebra in the paper? and can you estimate the percentage of those who will not be vanquished by your calculus?

Estimated in time, when the limit of elasticity of your audience will be reached, when will permanent set begin, how

much extension may be expected, and how much will the area of your audience be reduced before rupture takes place?

In some cases—as in political meetings—it might be well to consider whether the reaction at the point of rupture may not be violent.

It would seem as though a study of the laws of intellectual elasticity would have an analogous result to that which followed a knowledge of the principles of physical elasticity—in the one case mechanical structures were made safer, in the other there would be much less risk that meetings for technical discussion would fail in the purpose for which they are held, which, it may be assumed, is for the entertainment, instruction and profit of those who attend them.

NEW PUBLICATIONS.

Helical Gears. *A Practical Treatise.* By a Foreman Pattern-Maker. Macmillan & Co., New York.

This book gives very clear and detailed directions for the guidance of the pattern maker in laying out, constructing, and molding helical gears—that is, gears in which the acting surfaces of the teeth, instead of being parallel with the axes of the wheels, as in ordinary spur and bevel gears, are helicoids about these axes. The practical instruction is so explicit, that a pattern-maker, by carefully following it, could produce the best attainable results with very little original thought or invention on his own part. Considerable information is also given as to methods of molding these gears, and altogether the subject is placed in a clearer light, and its possibilities and difficulties more fully explained, than ever before in type.

The author's claims as to the advantages of helical gears, and the more theoretical parts of the book generally, are not quite as happy as those parts relating to the actual making of the patterns. For instance, on page 4, he states that the diagonal thrust, which takes place at all points of contact situated away from the actual pitch point of cycloidal gears, is an evil inseparable from the action of ordinary gears which it is desirable to eliminate. If this is such an evil, why is it that involute teeth, in which this diagonal thrust is always present, even at the pitch point, are being so largely used in the best practice of to day, and are rapidly supplanting the cycloidal shape? Again, the statement that the driving force undergoes constant variation as the point of contact between the teeth moves away from the pitch point is very misleading, as we know that with properly shaped teeth the driving force is constant throughout the whole arc of action. The claim on page 6 that with helical teeth "the wheels would revolve by rolling contact without sliding, and thus approximate to the condition of ideal cylinders rolling by the contact of smooth peripheries," would be rather difficult to sustain.

Helical gears would be used much more generally if they could be made as accurately and as cheaply as ordinary gears, and anything which tends to clear up the mystery surrounding them, or to simplify the methods of making them, or to improve their shapes and accuracy, is very desirable. This book undoubtedly has this tendency, and is a valuable addition to the literature on the subject. It will prove of interest and use to any pattern-maker or draftsman who has much to do with gearing of any description, and should be carefully studied by all who wish to make this kind, or are inclined to the belief that their use would be beneficial or profitable.

Hydraulic Testing-Machines. *System of A. H. Emery, C.E.* As Designed and Built by William Sellers & Co. (Incorporated), Philadelphia.

This publication is a pamphlet of 14 pp., $7\frac{1}{4} \times 7\frac{1}{4}$ in., in which the general principles of the Emery testing machine are first described; extracts from reports on the machine made to the Institution of Civil Engineers, the American Association of Mechanical Engineers, and the American Institute of Mining Engineers, are then given. The latter part of the book has the title of "Specification," but it is really a description of the construction of different types which are made by this firm. To those who are interested in the subject of testing machines, and have comparatively little knowledge of them or of the Emery machine, this part of the publication under review will seem quite too brief and lacking in lucidity. It is very doubtful whether any one, even the most skilled mechanic, could get a clear idea of the general construction of the machine from the description given. If one or more sectional drawings had been added, showing its principal parts or organs, with letters of reference, the reader would have had an image of these parts and their relation to each other which would have helped him immensely and enabled him to understand the general construction without difficulty.

The pamphlet before us is illustrated with half-tone engravings of a Hydraulic Support Testing Machine of a capacity of 500,000 lbs., Horizontal Type Machines of 100,000 lbs., 200,000 lbs. and 300,000 lbs. capacity, and a Pump for Testing Machine with Adjustable Stroke.

The following extract will interest the general as well as the technical reader:

"One of the 'proof' experiments by the United States Government Board was the breaking in tension of a forged iron link, 5 in. in diameter between the eyes, at a strain of 722,800 lbs., and immediately thereafter a single horse-hair seven thousandths of an inch in diameter was slowly strained, and after stretching 30 per cent., snapped under the recorded strain of 16 oz. Masses of metal were subjected to pressures of 1,000,000 lbs. in compression alternately with eggs and nutshells, and in all cases the machine operated with equal accuracy."

The typographical work of this catalogue is by the well-known J. B. Lippincott Company, and is all that could be desired.

What an Engineer Should Know about Electricity. By Albert L. Clough, E.E. The Mason Regulator Company, Boston, Mass. $4\frac{1}{4} \times 6\frac{3}{4}$ in., 108 pp.

The object of this book, the author says in his preface, is "to present plainly and without the use of difficult technicalities or mathematics, to all who have to deal with electrical appliances, brief descriptions of their various forms, practical 'pointers' on the troubles to which they are liable and their remedies, as well as general instructions for doing simple construction work, such as is often needed, as a slight extension of an already established plant."

It begins with some preliminary explanations and definitions about electricity circuits, volts, ampères, ohms, etc. Part I is on Light Current Working, and contains sections on the Battery, Circuits, Electric Bells, Burglar and Fire Alarms, Electric Gas Lighting, Dynamos. Part II is on Heavy Current Applications, and discusses Incandescent Electric Lighting, Arc Lighting, Transmission of Power, Storage Batteries, and ends with the Rules and Requirements of the Underwriters' Association with reference to the use of electric appliances.

The book is written in very simple and clear language, and is full of information for those who have the care of electric appliances. The deficiency in it seems to be that it is assumed that the novice knows more than he really does, and matters which no doubt are extremely plain to the writer are not sufficiently explained. The book is also without an index, which is an unpardonable literary sin.

The National Car and Locomotive Builder. This publication comes to us each month apparently undiminished in prosperity by hard times, and with no loss of interest on account of the dullness in business. The February number contains a number of very interesting articles—one on Passenger Car Construction, by Ernest Merrick, in which some new methods are described, and in which it is proposed to abandon the use of end platforms. Another article is a report on the Best Method of Securing Cylinders, Smoke-Boxes, and Frames on Locomotives, which was made to the Southern & Southwestern Railway Club. Some of the circulars of the Master Car-Builders are reprinted, and much other information is given which will interest those who are concerned in the construction or maintenance of rolling stock. One editorial article, however, is not cheerful reading. It discusses the question, "Where is the safest place on a train?" and points out with considerable minuteness of detail and show of technical knowledge when and where a traveler is most likely to have his neck or his bones broken.

It is announced that the directory of railroads and railroad officers, which is so useful and convenient an appendage to this publication, has been officially corrected, and that the publisher has abandoned machine-set for hand-set type, and prognosticates a generally improved tone in business, for which we are all looking so anxiously. There is a kind of satisfied tone about the publication which implies a comfortable bank account and general prosperity.

RAILROAD CAR JOURNAL. The bound volume of the *Railroad Car Journal* for the year 1893 comprises a very complete record of what has been done in car construction during the past year. While it is almost absolutely impossible, as all railroad men are aware, to obtain matter in regard to the car construction and car designing which bears the stamp of absolute novelty, yet the illustrations and the matter contained in the paper under review constitute a valuable record of current practice and of what has been done in the past. There are numerous working drawings which afford all the information which would be required for a duplication of the original in the shop, as well as photographs of perspective views giving an idea of the external appearance of the cars and car machinery described. The paper is neatly printed, and evidently considerable care is taken in the selection of matter and in the editing of the same, and the whole contains a deal of valuable information for car builders.

AN ELEMENTARY TREATISE ON THE STEAM ENGINE, *with Questions for Examination.* By Randall W. McDonnell. Dublin: William McGee; London: Marshall & Co. $7\frac{1}{4} \times 4\frac{3}{4}$ in. 48 pp.

The supply and demand for books on the steam-engine seem to be unlimited, and yet an editor of a technical journal is seldom puzzled more than he is when asked to recommend a book on this subject.

The little volume before us, we are informed, is the work of a very young man, who has evidently tried to explain what he has learned from books and other sources, and has done it very well. It begins with an explanation of the old Newcomen's engine and then advances to Watt and to modern practice. It is obviously the work of an amateur author, but is better than many books by writers of more mature years.

DYNAMO AND MOTOR BUILDING FOR AMATEURS. By C. D. Parkhurst, U.S.A. The W. J. Johnston Company, Limited, New York. $6\frac{3}{4} \times 4\frac{3}{4}$ in., 163 pp.

This simple book is "an attempt to describe to amateurs such forms and types of motors and dynamos as are simply and easily made." It contains directions for making A Small Electric Motor for Amateurs; A "Home-Made" Electric Motor; A Sewing-Machine Motor for Amateurs; Armature Windings; Connections and Currents; A Fifty-Light Incandescent Dynamo, and an Appendix.

The book is clearly written, with very full and detailed directions for doing what it was the purpose of the author to explain.

TRADE CATALOGUES.

THE LUNKENHEIMER COMPANY, of Cincinnati, have issued a neat folder illustrating their "Renewable Seat-Gate Valves," of which different styles are represented, with a table giving price-list, dimensions, weights, etc.

THE YOUNG & WILLEVER AUTOMATIC MECHANICAL RAILROAD BLOCK-SIGNAL COMPANY, of 204 Walnut Place, Philadelphia, have issued a small—$5\frac{1}{4} \times 8\frac{1}{4}$ in.—circular of 8 pp., containing a description of their block signals. It is to be regretted that this description is not accompanied with engravings of their apparatus, as no one can get a clear idea of its construction without such illustrations.

THE DETRICK & HARVEY MACHINE COMPANY, of Baltimore, send us a neat pocket diary and memorandum book for 1894. It contains some useful data about population and postage and calendars for 1894 and 1895. It also conveys the information—and this is perhaps its most important function—that the publishers are Designers and Builders of Experimental and Special Machinery of all kinds and Manufacturers of the Open Side Planer.

THE MAGNOLIA METAL COMPANY, of 74 Cortlandt Street, New York, have published a sheet containing half-tone engravings of 22 different bearings. These apparently are shown as they appeared after being tested, but the whole matter is presented in such an incoherent way, both typographically and rhetorically, that it is not easy to get at the significance of the illustrations or the fragments of reports accompanying them. The purpose of the publication is to show that Magnolia metal came out ahead, in some tests which were made somewhere by somebody, but neither the place where the tests were made nor the parties who made them are clear from the publication before us.

KNOWLES SPECIAL CATALOGUE OF POWER PUMPS, *for Paper and Pulp Mills.* Knowles Steam Pump Works, 93 Liberty Street, New York. $5\frac{3}{4} \times 7\frac{3}{8}$ in., 31 pp.

The publishers say of this that it is a special catalogue of paper-maker's belt-driven pumps. The following different kinds of pumps are illustrated and described by excellent engravings and clear descriptions: Vertical Triplex Boiler Feed Pump, Horizontal Single Boiler Feed Pump, Horizontal Duplex Light Service Pump, Vertical Triplex Pressure Pump for Hydraulic Pulp Grinders, Horizontal Duplex Pressure Pump for Hydraulic Pulp Grinders, Vertical Post Stuff Pump, Vertical Fly-wheel Stuff Pump, Vertical Fly-wheel Post Stuff Pump, Vertical Duplex Geared Stuff Pump, Triplex Stuff pump, Suction-box Vacuum Pump, Vacuum Pump for Revolving Suction-box, Vacuum Pump for Sulphite Process, Underwriter Fire Pump, Automatic Receiver and Pumps.

The engraving, printing, and descriptions are all excellent.

BALL BALANCED COMPOUND LOCOMOTIVE. 21 pp., $6\frac{1}{4} \times 9\frac{1}{4}$ in. This pamphlet describes a form of locomotive with outside cylinders arranged "tandem" fashion. The centers of the two low-pressure cylinders are sufficiently near together to be connected to crank-pins close to the wheels. The centers of the high-pressure cylinders are farther apart, and they are connected, by separate connecting-rods, to pins on return cranks attached to the main crank-pins. These two pins are set opposite to each other, so that the reciprocating parts of one cylinder balance those of the other. The trailing wheels also have return cranks, and there are two coupling-rods on each side of the engine, which is of the American type.

There are also illustrations of an eight-wheeled suburban locomotive of the Forney type with the balanced compound features adapted to it. These are all very well illustrated, the engravings being made from excellent drawings, but which have been reduced too much, the dimensions being illegible.

The office of the Company is at 82 Church Street, New York.

AFTER THE FAIR. *Twenty-fifth Anniversary Souvenir of the Page Belting Company.* Concord, N. H. $6\frac{1}{4} \times 9\frac{1}{4}$ in., 36 pp.

The purpose of this pamphlet is to publish the judges' reports and awards which were made to the Page Belting Company, for leather belting exhibited at the Columbian Exhibition, and also to illustrate and describe their exhibits at the great "show." The first few pages are devoted to the awards and reports, and to "Corroboratory Testimony" of those awards. This testimony consists of a series of letters from the parties who used the Page belting at the Exhibition. These are followed by a series of half-tone engravings showing the various exhibits of the Company with descriptions thereof. There is also a history of the Company with a view of their original shops of 1868, and of their present works at Concord, N. H. The last page contains views of their warehouses at 91 Liberty Street, New York; 31 Pearl Street, Boston; 165 Lake Street, Chicago, and 42 Sacramento Street, San Francisco. On the last outside cover is a diagram showing a whole hide of leather, and descriptions of how it is cut to make different kinds of belting.

WHEELER'S IMPROVED SURFACE-CONDENSERS. Wheeler Condenser & Engineering Company, New York. $9\frac{1}{4} \times 5\frac{3}{4}$ in., 20 pp.

The outside cover of this publication has an excellent engraving showing a section of the Wheeler Surface Condenser. It is printed in three colors, the outlines being black; the brass parts are shown in yellow, and the iron or steel parts in blue.

The introductory part of the pamphlet sets forth the "Advantages" of the condenser, and says that when there is a sufficient supply of water available, any existing high-pressure engine can readily be converted into a condensing engine with a resulting economy of from 15 to 25 per cent. of fuel. A description of the construction and operation of the condenser and of the improved "Wheeler Admiralty Tube," which is used, follows. This is succeeded by excellent wood-engravings, showing perspective and sectional views of different

kinds of surface condensers made by this Company. An illustration of a jet condenser, a view of their works at Carteret, N. J., completes this pleasing and satisfactory publication. It may be added that the New York office of the Company is at Nos. 39-41 Cortlandt Street.

HYATT ROLLER BEARING COMPANY. 12 pp., $5\frac{3}{4} \times 9$ in. Roller bearings have been the subject of the dreams of innumerable inventors for a great many years past. In the pamphlet before us it is said that more than 300 patents have been issued in this country on such bearings, and yet comparatively few are now in use, and those only under slow-moving mechanism. Roller bearings which have heretofore been made had to be turned, hardened and accurately finished. The same is true of ball bearings. The Hyatt bearing is an ingenious device to get over the difficulties encountered in other similar bearings, and consists of *flexible* bearings. They are made of a ribbon or flat bar of steel wound on a mandrel to form a close spiral, and it is claimed that "such a roller adapts itself perfectly to every inequality of the axle or the bearing, and cannot be crushed or distorted by side strains on the bearing or bending of the journal." It is also said that such bearings do not require to be turned or finished in any way, and are therefore much cheaper than any other roller or ball bearings which have heretofore been proposed. The idea is a very ingenious one, and has in it a promise of great success.

Various forms and applications of the bearings are well illustrated and described in the pamphlet which has been issued by the Company, whose office is at 77 Liberty Street, New York.

THE HISTORY OF A LEAD-PENCIL. By Walter Day. The Joseph Dixon Crucible Company, Jersey City, N. J. $6\frac{3}{4} \times 5\frac{1}{4}$ in., 16 pp.

Probably of the millions of people who daily use lead-pencils very few have any idea of how or where they are made. The little publication which the Dixon Crucible Company has just issued gives a great deal of interesting information about the different kinds of pencils which they make, how they are manufactured, and why. The pamphlet is as interesting as a good novel, and probably few who have the time to read it will lay it down without finishing it.

The first part of the description, however, has a sort of strident personal flavor, which may have somewhat the same effect on its readers that those people have who take the liberty of slapping us on the back or punching us with their sticks or umbrellas. The author has taken liberties with the reader which are not entirely agreeable. He begins with the imperious command, printed in caps, "TAKE THAT PENCIL OUT OF YOUR POCKET." It would not be pleasant to have a stranger say that to us, nor is it pleasant to read. The first person singular occurs oftener, too, than is agreeable. Barring these slight lapses of good taste, this little history is very pleasant and profitable reading. It is well illustrated with excellent wood cuts of the mines, mills, and works of the Company, a portrait of its founder, various kinds of pencils made by it, and finally a view on Crystal River, Fla., showing the rafting of cedar logs to the Dixon mill, with a fine alligator in the foreground, who evidently is not happy because he is not provided with a Dixon pencil.

OUR SHARE IN COAST DEFENSE—*Part II.* Builders' Iron Foundry, Providence, R. I. 55 pp., 6×9 in.

In the brief preface to this pamphlet the publishers say that, "In publishing the pamphlet 'Our Share in Coast Defense—Part I,' we gave in popular form a rather brief description of the 12-in. Breech-Loading Rifled Mortars and the methods which we employ in their manufacture. We now supplement that pamphlet by reprinting extracts from Government Specifications and Inspectors' Reports, believing that more complete descriptions, exact particulars, and minute details will interest mechanical engineers and others who follow advanced foundry and machine-shop practice."

The frontispiece is a half-tone engraving, showing the 12-in. breech-loading rifled mortars, which was published in THE AMERICAN ENGINEER of last September. This is followed by specifications of their manufacture, with illustrations of the form and position from which test pieces are taken. An outline engraving and outside dimensions and another sectional view of one of the mortars is then given, with specifications governing the finishing and assembling thereof. Other interior views in the foundry are also given, with an outline view of an old style 13-in. seacoast mortar. The metal which is used and the process of manufacture is described, and reports of tests of the materials used are given. A description of the method of operating the breech mechanism, with illustrations of it, completes the work. It is all written in a popular way, and will interest all who are concerned in the subject which it discusses. An omission to be noted is the absence of titles to most of the engravings. A very large proportion of the people into whose hands any book falls never go further than to look it through. To such proper titles to engravings are a great help.

THE CONSOLIDATED CAR-HEATING COMPANY, of Albany, have sent us a poem, by Haines D. Cunningham, "the well-known newspaper correspondent," with the title "The Car-heater and the Traveling Public." We have only room for the following lines, which are submitted as a sample:

"And in daytime, midst his dreaming,
Sits the solitary traveler
Peering through his frosted window,
Out upon the dreary landscape
Drifted high with crystal hillocks,
Sicklied o'er with pale solstitial
Sunlight of the cold north winter,
While his feet are warm, and legs, too,
Dangling limp against the pipe-ways."

The last line of our quotation, it will be seen, does not "even up" quite right. The following amendment is therefore suggested:

"While his feet are warm, and legs, too,
His corns are aching in a tight shoe."

Seriously, we think the Consolidated Car-Heating Company's system of heating is better than Mr. Cunningham's poetry, and, by means of the Sewall Steam Coupler, the lines of pipe on the cars are connected together more satisfactorily than some of the lines of the poetry are. Still, there are some strokes of genius in the poem. For example, the following line addressed to the locomotive:

"In your big, black, bulbous boiler."

In a paragraph from the Manitoba *Free Press* the Consolidated system of steam heating, which has been adopted on the Canadian Pacific Railroad, is commended. We have not received any newspaper clippings commending the poetry

BOOKS RECEIVED.

Bureau of the American Republics. Monthly Bulletin, December, 1893.

The Political Economy of Natural Law. By Henry Wood. Boston: Lee & Shepard.

Sixth Annual Report of the Board of Mediation and Arbitration of the State of New York. Albany: James B. Lyon, State Printer.

Rules for Operation of Steam Heating Systems, Baker Heater, and Pintsch Gas. Published by the Baltimore & Ohio Railroad Company.

Consular Reports. January, 1894: Commerce, Manufactures, etc. (Packing Goods for Export.) Washington: Government Printing Office.

The National Geographic Magazine, January 31, 1894: *Proceedings of the International Geographic Conference in Chicago, July* 27, 28, 1893. Washington: Published by the National Geographic Society.

Immigration and Passenger Movement at Ports of the United States during the Year ending June 30, 1893. Report of the Chief of the Bureau of Statistics. Washington: Government Printing Office. 64 pp., $9 \times 5\frac{3}{4}$ in.

The Foreign Commerce and Navigation of the United States for the Year ending June 30, 1893. Prepared by the Chief of the Bureau of Statistics of the Treasury Department. Washington: Government Printing Office. 670 pp., $11\frac{1}{4} \times 8\frac{1}{4}$ in.

Engineering Education, being the Proceedings of Section E of the World's Engineering Congress held in Chicago, Ill., July 31 to August 5, 1893. Published by the Society for the Promotion of Engineering Education as Volume I. of their Proceedings. Edited by De Volson Wood, Ira O. Baker,

J. B. Johnson, Committee. Columbia, Mo.: E. W. Stephens, Printer. (This volume is to be had of Professor J. B. Johnson, Secretary, Washington University, St. Louis ; $2.50.)

SAVING EFFECTED BY COMPOUND LOCOMOTIVES.

Editor of the AMERICAN ENGINEER AND RAILROAD JOURNAL :

Apropos of a recent discussion relative to the merits of the compound locomotive, I am now able, fortunately, to give you some data relative to the action of a compound locomotive on the Chicago, Burlington & Quincy Railroad, which, I think, will be of interest.

The data was gathered, not to determine the merits of the compound locomotive, but because the general officers thought the coal record for a certain month was too high on the division on which the compound was running, so that the report contained the fuel record of the compound. The fuel used by each engine and the number of loaded cars hauled was looked up for each engine. The results are stated in the number of pounds of coal burned in hauling one loaded car 1 mile. The record for the compound was 3.27 lbs. of coal per loaded car mile. The best record for any simple engine of the same class was 3.85 lbs.; for the poorest, 6.32 lbs.; for the average of 40 engines, including the compound, 4.61. So that the saving made by the compound was as follows : Over the best record of any other engine in the same class, 15 per cent.; over the poorest record of a simple engine, 52 per cent.; over the average record of 40 engines of the same class, 29 per cent. As the compound runs in the pool with all the other engines, as the record covers the period of a month, and is almost a duplicate of a similar record made when the engine was new, it seems to me there is no escape from the conclusion that this compound, at least, is saving us at least 25 per cent.

C. H. QUEREAU,
Engineer of Tests.

MARINE NOTES.

Japanese Torpedo-boats. — Seventeen torpedo-boats are now in course of construction at the navy yard at Kobe, Japan.

The Chinese Navy Worthless.—It is stated at Shanghai, "on excellent authority," that the real reason why none of the Chinese squadron went to Bangkok was that it was found there was not one of the squadron prepared for such a voyage without refitting, the internal condition of the ironclads and cruisers of China's new navy being very imperfect.—*London Daily News.*

The Loss of the "Kearsarge."—The old corvette *Kearsarge*, of the United States Navy, was foundered on Roncador on the night of February 2. She is one of the two vessels, the *Hartford* being the other, which, by special act of Congress, was to have been kept in commission. Her principal victory, for which she is noted, was the destruction of the English-Confederate cruiser *Alabama*, off the coast of France, during our late Civil War.

A Commerce Destroyer.—Sir E. J. Reed, speaking recently at a banquet at Cardiff, said that "he was concerned at the present moment in the construction of a foreign cruiser, a vessel without any armor at all, and without any pretension to be anything but a very fast vessel built for the purpose of causing what mischief she could under certain conditions. He had no hesitation in saying that every one of the guns she carried could penetrate the unarmored ends of 10 of the British line-of battleships, which, being so penetrated, must sink.

The Cruiser "Olympia."—The report of the trial board on the speed of the new cruiser *Olympia*, which was run in the Santa Barbara Channel off the coast of California, gives the vessel a speed of 21.686 knots, which means a premium of $300,000 to the builders. In every point of machinery, speed, H.P., and coal consumption the plans and specifications have been beaten. The required pressure test was 160 lbs., that carried was 166.53 ; at the starboard engines steam-chest the register was 166.75 ; at the port engines, 164.83.

The Cruiser "Montgomery."—The trial of the cruiser *Montgomery*, which was held off New London, in Long Island Sound, shows that the vessel developed a speed of 19.056 knots. Her contract called for a speed of 17 knots, and this will mean a bonus of $200,000 to the builders, the Government paying $25,000 for each quarter knot in excess of the contract speed. The average revolution of the port engines during the trial were 180.7, and of the starboard engine 180.3 ; the average steam pressure 160 lbs. On a requirement of 16,000, the main engine's indicated H.P. was as follows: Starboard, H.P. 2,001 ; first I.P. 3,097.3 ; L.P. 3,198.5 ; total, 8,297.6 ; port, H.P. 1,903.2 ; first I.P. 3,185.6 ; L.P. 3,463.4 ; total, 8,552.2 ; grand total for main engines, 16,849.8. The collective H.P. of the main and auxiliary engines operated during the trial amounted to 17,313.08.

It will take from seven to eight months to put the finishing touches on the *Olympia* so that she can be declared in commission.

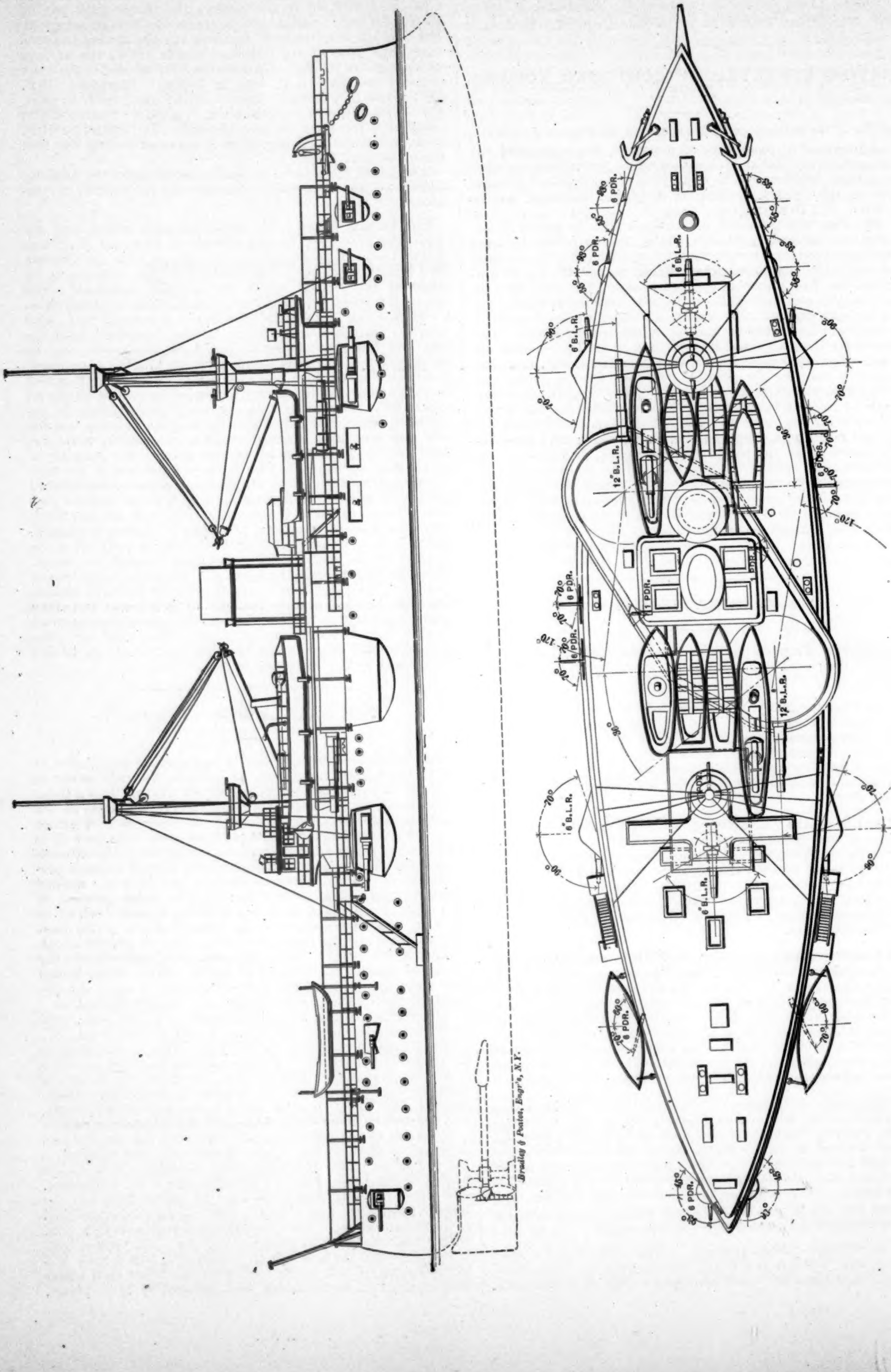
Life-Saving Kites.—We called attention in our issue for September, 1893, to the experiments of Professor G. Woodbridge Davis, in sending a life-line ashore from the Brenton Reef lightship. These experiments have been followed up by others at Sandy Hook, which were equally successful. The kite used is foldable ; the sticks are of light ash revolving upon a common center axle, and the frame is covered with oiled muslin. Instead of a single line leading from the face of the kite, two lines are employed, one from either side, and by checking one or the other a trifle after the kite has been raised, it may be directed four compass points or 45° from its direct leeward course, so that it may be landed anywhere within an area of 90°. The value of this steering property may be appreciated when it is explained that it often happens that the only near land to a wrecked vessel is not directly to the leeward, but to the right or left of that point. The principle of the steering action of the kite is based upon that of the fore-and-aft sail, which may be trimmed to a certain limit without spilling the wind. As soon as the kite is raised and the guy-lines adjusted so that it is directed aright, these are secured to a wooden float or buoy, and the latter is thrown overboard, having to it a light but strong line which is paid out as the kite flies to the land, dragging the buoy through the water. When the float reaches the beach the life-saving crew detach it and bend on to the ship's rope the regular lines and blocks, which the wrecked seamen haul out to their vessel and make secure, according to the directions found painted on the small wooden tags fastened to the blocks. The crew are then brought to land either in the breeches-buoy or life-car hauled out to them by the life-saving crew.

THE BATTLESHIP "TEXAS."

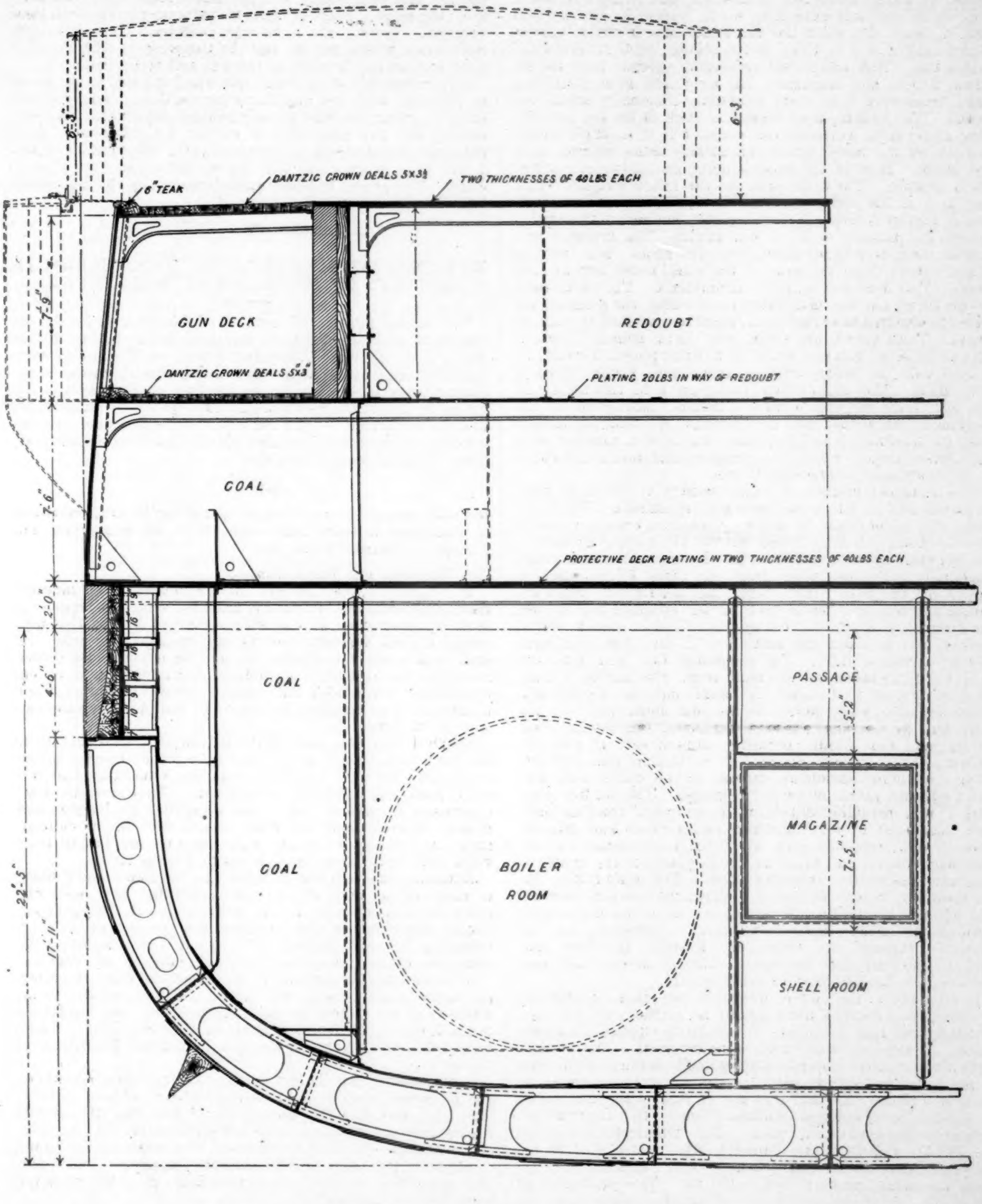
THE battleship *Texas*, which is now nearing completion at the United States Navy Yard, at Norfolk, Va., will be one of the most powerful battleships of the new Navy. It is a twin-screw vessel of the belted type, built after the designs of the Barrows Ship Building Company. It has a belt of armor admidships to protect the vital portions of the ship, as well as under-water decks from the ends of the armor to the extremities of the vessel. Her dimensions are : Length between perpendiculars, 290 ft.; extreme breadth, 64 ft. 1 in.; molded depth to upper deck, 39 ft. 8 in.; draft of water forward, 22 ft.; draft of water aft, 25 ft. 5 in.; giving a mean draft of 22 ft. 6 in. The displacement when brought down to this draft is 6,300 tons, and the transverse meta-center of gravity is calculated at 3 ft. 1⅘ in. The longitudinal meta-center above the center of gravity is estimated at 237 ft. When being loaded the vessel drops 1 in. for each additional 30 tons, and the moment required to change the trim 1 in. in 1 ft. is 432 tons.

The engines, which we will illustrate in a later issue, were built by the Richmond Locomotive Works, at Richmond, Va., from designs approved by the Navy Department, and have an indicated H.P. of 8,600. As the vessel is intended purely as a fighting machine, no attempt has been made to give her the excessive speed which has been attained by the cruisers *Columbia* and *New York ;* therefore her maximum speed is 17 knots, and she will be given a complement of 300 officers and men.

Referring to our cross-sectional engraving, the vertical keel is made of steel 20 lbs. to the square foot, and reduced to 11¼ lbs. at the ends. It is 39 in. deep amidships, with double angles at the tube of 3½ × 3 in., weighing 8 lbs. to the foot. The outer flat keel weighs 25 lbs. per square foot, and the inner 17½ lbs. to the square foot. From the fourth longitudinal to the armament shelf, the outer and inner angles are 3½ × 3 in. with a plate between lightened with holes. The frames both before and abaft the armor both consist of Z bars 6 × 3½ × 3 in., weighing 15 lbs. to the foot, with the lower ends where they come down on the armor deck secured by 15-lb. plates,



SIDE ELEVATION AND DECK-PLAN OF UNITED STATES BATTLESHIP "TEXAS."



HALF CROSS-SECTION OF THE UNITED STATES BATTLESHIP TEXAS.

and they are split where coming down to the keel with a 10-lb. floor-plate riveted in. The bottom plating is 17½ lbs. per square foot, and runs up to the armor deck and protective deck; above this it weighs only 15 lbs., but is increased to 60 lbs. in the wake of the machine guns. The inner bottom is 10 lbs. per square foot. The vessel has two masts, each with military tops. The vital portions of the vessel are protected by a steel armor belt 12 in. thick, and rising 2 ft. above the water-line, and extending 4½ ft. below it. At a point 18½ in. below the water-line the armor belt begins to narrow down until it is 6 in. thick at the bottom, or 4½ ft. below the water-line. This armor belt protection extends over the engines, boilers, and magazines, and terminates at each end in a steel breastwork 6 in. thick extending diagonally across the vessel. The backing is of wood 6 in. thick at the top and vertical at the back, so that at the bottom it is 12 in. thick widening out on the bevel, which has already been referred to in the armor. Back of the wood packing are two thicknesses of 25 lb. plating. The shelf plate for the armor weighs 25 lbs., and back of this plating and behind the packing are two horizontal girders formed of 15 in. plating secured to the plating behind the packing by 3½ × 3-in. angles. The armored protective deck is worked down over the armor, both sloping slightly down from the ends of the vessel to the bow and the stern. This deck is 3 in. thick throughout. The lower parts of the turret and the machinery for working the guns are encased in armored redoubts 12 in. thick and backed by 6 in. of wood. These turrets are plated with 12-in. armor. There is also an armored conning tower 12 in thick placed forward on a level with the bridge with an armor tube leading from it 3 in. thick. The ammunition masts are 6 in. thickness. In our next issue we will publish a detailed description of the sections of this turret, with the hydraulic operating mechanism used for handling it and the guns, which was, together with the engines already referred to, designed and built at the shops of the Richmond Locomotive Works.

The armament consists of a main battery of two 12-in. guns in turrets and six 6-in. guns protected by shields. The 12-in. guns will be mounted in turrets placed *en échelon*, so as to give a fore-and-aft fire. These turrets are further encased in the diagonal redoubt, which is heavily armored and extends diagonally across the vessel from one turret to the other, as shown on the plan. Each turret has a complete broadside fire on one side, and has a train on the opposite side 40° for the forward gun and 70° for the aft. A 6-in. gun is placed forward and on about the same level as the 12-in. gun, each having a train of 120°. The remaining four 6-in. guns are mounted in sponsons on the main deck, two having a train directly forward to 25° abaft the beam, and two directly aft. These are also clearly shown on the plan engraving. On the main deck the secondary battery consists of four 6-pdrs., four 3-pdrs., and four 47 mm revolving cannon, each of which is protected by 1½ in. steel plating. Two Gatling guns and two 37 mm. revolving cannon are located on the bridge deck, and two 1-pdrs. are placed on the firing bridge. Two Gatling guns with 47 mm. revolving cannon are to be fought from the military mast tops to repel boarders and torpedo-boat attacks. Two 37 mm. rapid-fire guns are fitted in the steam cutters. The magazine for the main battery is placed in the center of the vessel below the protective deck. The ammunition for the secondary battery is stowed in magazines located forward and aft, the ammunition being passed up to the main deck through an armor tube 3 in. thick. Torpedoes can be projected through six tubes, one through the bow, one through the stern, two through the side aft above water, and two through the side forward below water.

In reference to the motive power, as we intend publishing in a later issue detailed drawings of the engines, we will simply state here that it consists of two triple-expansion engines placed in separate water-tight compartments. The water-tight compartments here run longitudinally through the length of the boiler and engine space, or equivalent to the length of the armor plate. Aft and forward of these points the vessel is divided by transverse bulkheads only, the longitudinal bulkheads stopping at this point. The cylinders and engines are 36, 51, and 78 in. in diameter, with a stroke of 39 in. There are four double-ended boilers 14 ft. diameter × 17 ft. long, the steam pressure being 150 lbs. The grate-area is 504 sq. ft. As the engines are to be run at all times under an air pressure, the maximum of which is 2 in. of water, the indicated H.P. will be 8,600. Five hundred tons of coal can be stowed, and this is calculated to give an endurance at a speed of 17 knots of 1,110 nautical miles; at 15 knots, an endurance of 2,050; and at 12 knots will be 3,170 nautical miles. With a coal supply of 850 tons the endurance is, for a speed of 16½ knots, 2,180 miles; at 14.75 knots, 3,900 miles; 11.8 knots, 6,000 miles.

The vessel is to be fitted as a flag-ship. Directly aft on the gun deck there will be a private cabin for the admiral, and forward of this will be his dining-room and sleeping-cabin. Next will be the admiral's bath, closet, and pantry. Forward of these there are similar accommodations for the captain. Forward of this, extending across the vessel, is an open space with two passages leading forward from it. These passages enclose the ward-room, and the state-rooms open into them from the sides. There are nine state-rooms opening into these passages. Beyond the ward-room bulkhead there is a large open space which can be used by the steerage officers. The crew are berthed forward on the gun and berth decks.

At a recent visit to the vessel she was lying tied to the wharf at Norfolk, with her machinery in position. Nearly everything in connection with the engineering department is already located, and the delay now is waiting for the armor. It is expected that this will be delivered early this month and that it will be in position, so that the sea trials can take place in June. The armor is being manufactured by the Bethlehem Iron Works, at South Bethlehem, Pa.

MEETING OF MEMBERS OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

The second meeting of members of this Society, for the discussion of technical subjects, was held in the hall of the Society, at No. 12 West Thirty-first Street, on Wednesday evening, February 14. The subject which was discussed at the January meeting—"The Development of Stationary Engines, as illustrated by those exhibited at the Columbian Exhibition in Chicago"—was continued at the last one. Professor John E. Sweet, of Syracuse, N. Y., read the opening address, to which he gave the title

PRIMING,

probably because it was intended as a stimulus to the members in attendance to shoot their guns off in the subsequent discussion. Professor Sweet said:

Mr. Chairman and Fellow-Members:

If I rightly caliper the aim the promoters of this monthly meeting scheme had in view in selecting some one member to open the discussion, it was with a view of having that individual discuss something of interest, or say something that shall inspire others to discuss it; and the object of the discussion is for the exchange of thought, the advancement of our engineering knowledge and practice, or the heralding of our mechanical achievements as a sort of mutual admiration society in disguise.

From all that was said about the modern steam-engine at the previous meeting, there is but little left of interest for me to say, and my only hope lies in saying something that will strike flashes of inspiration from others. There are two ways to promote discussion: one to say something the listeners like to hear, whereat many are ready to add their hearty endorsement, and the other to say what they do not like to hear, which will bring up as many to refute the assertions.

Assuming that you will all agree that the latter plan is likely to make things more lively, your committee may well congratulate themselves in having selected for this purpose one whose proverbial modesty entitles him to the privilege of ridiculing the past, finding fault with the present, and criticising the future; besides abusing the fraternity in general.

In considering the present, let us review the past; and trusting you will allow me, I will go back to the first step in the stairway of my interest in steam engineering, the Exhibition of the Royal Agricultural Society, at Battersey Park, in London, 1862, or 31 years before the Columbian Exhibition at Chicago.

I remembered that there was a lot of portable engines there, and so turned back to some printed letters written home at that time, and find this paragraph: "But one still greater feature than all was the almost incredible number of portable steam-engines—83 different ones—all with steam up and going at the same time and driving threshing machines, straw cutters, grist-mills, tile and brick machines, etc. Six or seven were traction engines."

To this I might add something about steam plowing, which was then and still is successfully practised in England, and the steam road rollers, which were common; but I do not call up this subject to show how we outstrip all other nations (in following in their foot-steps), but to call attention to this branch of steam engineering (which has not been thus far considered) and to describe one of the many things I saw at Chicago which excited my liveliest admiration.

A traction engine of not the largest size, built somewhere in Ohio, well invented, not very well designed, frivolous in some of its details, and deplorable in workmanship, was harnessed to a 5-ton load of pig iron piled on a stone boat. The engine hauled that around over the dry ground with as much indifference as if it had been so many pigs of pork. It went down into the canal, wallowed around like a sea-lion, and out up a bank where one would not expect to see a team draw up a wagon. It was driven up to a railroad track where the ties had been blocked up until the top of the rails were 2 ft. above the level. The engine mounted this obstruction diagonally, first one forward wheel, then the other; then alternately the back wheels in like manner, running along over the ties and turning off diagonally as it had mounted—in fact, performing the feat precisely as an elephant would have done, and with like ease and indifference.

I was so astounded at this exhibition, so elated to see the justifiable pride shine out of the builder's countenance, that I did not stop to consider then, as I hesitate to question now, whether it would not have been better to build the engine with less of the spirit of a gymnast and more in line of durability in its legitimate work. Allowing the thing to be worth doing, the man who did it is never likely to receive half the credit he deserves. When the means are compared with the end, the builders of stationary engines and locomotives may take off their hats to the builders of traction engines, and call them brothers.

As the Cornish pumping engine set the pace in steam economy for half a century, so the Cardiff trial of portable engines 20 years ago set the mark so high that small engines of no kind have as yet in this country approached it. Compound portables have long been common in England, though they have not yet appeared here.

To go back to the same year 1862, the year of the second London Exhibition, my memory does not even picture the steam-engine exhibit, but I remember Mr. Porter exhibited a rapid-running engine, and patented, introduced and promoted the manufacture of the Richards indicator.

The next step on the exhibition ladder was the Paris Exposition of 1867. At that exhibition two engines of mark beyond all others set their hands upon the industrial world, and have held them there for a generation—the Corliss engine from the parent works at Providence, and the Porter-Allen, built by Whitworth. While the Porter-Allen was admired and the makers' name demanded respect, it was too novel, untried, or for some reason did not take root in Europe. The Corliss engine, new to the Continent, was admired for its silver jacket, polished bonnets and general trousseau, ridiculed for its complexity, but understood by the leading engineers of Europe. Although Mr. Corliss had no Continental patents, it was taken up by three or four of the leading manufacturers, and royalties paid the same as if he had held patents—honorable deeds certainly; and if they have been reciprocated in like manner to the least extent, the fact is not generally known. In plain English, if any American has paid a foreigner royalty on an unpatented invention, some of his friends should make it known.

While the natural sons of neither of these engines (the Corliss and the Porter-Allen) were shown at Chicago, what Chordal designated the Hyphen-Corliss and what may be styled the Fitzporter engines were too numerous to escape attention—in fact, they constituted the bulk of that wonderful collection in Machinery Hall. It may be true, and likely is, that there were high-speed engines built before the Porter-Allen engine, but it is one that still lives, and I fancy one that has suffered least by changes and modifications, certainly least of any in looks; it is the respected parent of a numerous group of sons and daughters-in-law that I shall speak of later.

Mounting the third step of our experience, the Centennial. While compound engines were quite common in Europe and on the sea, and Adamson had, I think, built his quadruple, none were shown at Philadelphia—in fact, our own engineers did not believe in them. Although the single-cylinder engine has been transformed into many shapes, it had then reached a pretty high state of completeness; the Buckeye, the only engine shown at both Chicago and Philadelphia, and the Corliss had reached the forms they followed for many years. The Corliss centerpiece, with its two single cylinders, walking-beam and 30-ft. gear, was one of the grandest steam-engine monuments in its impressiveness ever erected; but judged in the light of the present practice showed (as Mr. Porter pointed out at the time) just how not to do it. In explanation of this statement, it may be well to give the substance of a friendly criticism of the great Corliss triumph, held under its own shadow. It was, as you all remember, a beam-engine with two 40-in. cylinders, 10 ft. stroke, two walking-beams coupled to the two cranks of a shaft carrying a 30-ft. gear working into a pinion some 12 ft. in diameter, the engine making from 35 to 38 turns, and the second shaft about 90. By what process of reasoning our conclusions were arrived at I do not now remember, but it was agreed that two 40-in. cylinders at 4 ft stroke directly connected to the second shaft and run at the same piston speed would accomplish the result at an immensely less expense. The whole Chicago display shows that is what would now be done; and while Mr. Hemenway allows there has been a gain in pumping engines of only 20 to 25 per cent., I am sure the Allis Chicago engine will harvest 2 H.P. from the sowing of the same amount of coal that it would take to get one from the Corliss Centennial; which, as it was specially suited to compounding, and yet was not compound, shows that Mr. Corliss at that time had not been convinced that there was enough advantage to go to that slight additional expense.

I am well aware that it is almost sacrilegious to criticise the design of that wonderful Centennial monument, but shall do so in the belief that the very audacity of the thing will emphasize the point I wish to make. The design was in two distinct styles intermingled, just the wrong thing to do as well in machinery as in building. The framing was of the most severe straight lines, almost seeming to be simply a reproduction in iron of its wood prototype, while the beams were in graceful curves and the lever-arms of the valve motions not curves, but crooked and freely graceful. Milan Cathedral and the Corliss engine are noble examples of mixed architecture, but noble in spite of the mixture and not because of it.

When one sets himself the task of looking into this feature of machine design, he will find in it one of the explanations of why things do not look right. There is an engine of recent production where the arms of the wheels are elliptical, a conspicuous lever I-section, rocker-arms round, cylinder-head one style and steam-chest covers another, and yet there seems no apparent reason why, if the machine was consistently designed, it would not accomplish the work just as well as it does now. I am well aware of the danger one encounters in criticising designs, and to simply say one looks well and another not, without giving the reason, is setting one man's opinion against another; but certainly there is such a thing as consistency, which plainly is subject to demonstration.

Builders of the modern improved Jones, Smith & Brown Corliss engines found themselves confronted by this condition. Steam pressure had gone from 60 to 120 lbs., and something had to be done to meet the new conditions. Three methods were open to them: put in more iron, put it in a better form, or make more attachments to the foundation. As is usual with improvers, the most of them take the wrong road. Hicks & Hargraves, of Bolton, England, adopted the right plan on the start, by making the frame a complete box. The only Hyphen Corliss engine exhibited at Paris in 1867 was of this make and this form. At Chicago two of the Corliss type claimed to be box section, but the builders spent some money to spoil them by cutting ornamental holes through their vital parts.

A round column (not more than 24 diameters in length) cannot be improved, except by putting more metal in it. In any other form it can be by making it round. A round tube is not a suitable form for an engine bed, a rectangular one is, and is nearly as strong as a round one. Aside from the push and pull, the strain on a Corliss bed is a torsional one. A rectangular box will resist this strain about 16 times better than an I-beam of the same cross section. Against a push-and-pull strain a crooked element is a weak one. If it must be crooked, a box section is best able to resist it; but why crooked? There is plenty of room around a Corliss engine to make a bed straight and have it right, and when it is right it will look right, provided the designer has the ability and the observer the right training. This in no way means that everything should be straight, for as often, perhaps more often, the thing to be right has to be the furthest possible from that, and the one who makes the thing straight that should be crooked makes a worse blunder than the other.

As mentioned before, if there are two roads for an imitator to take to improve an original design, he will take the wrong one; so, too, if there is any one feature that is bad or less meritorious than another, he is sure to stick to that with a persistency worthy of the best, and mutilate the subtle beauties he cannot appreciate; and this confirms me in the notion I have always entertained, that the overhanging cylinder of the Porter-Allen engine is not right.

Of the dozen or two of engine builders, both those who allow that their engine beds are of the Porter-Allen type, and those who build the same thing without the allowance, adhere persistently to the overhanging cylinder, and remodel the graceful contour of the bed (which has never been equalled) with a freedom wonderful to behold.

They not only hang to the overhanging cylinder, but hang on another one, in looking at which I can only think of an

old man turning his back to the job, catching his boy and holding him out at arm's length, and the two working away with the old man's posterior as the business end of the combination. Some of them, fearing the boy will get tired, put a crutch under his back.

In the most recent developments of the man-and-boy scheme, as it appears to me, the old man sits down on the foundation and takes the boy in his lap; each, however, true to his association, holds to the overhanging cylinder.

I do not underestimate the animosity I am likely to excite by criticising designs, and offer the following in justification—not in justification as to the right and wrong of my opinions, but in justification of doing the thing at all. We all of us talk about each other's plans, whether cross, compound, tandem, quarter cut-off, clearance, horizontal, upright, Corliss, Willans, Sulzer, triple-expansion, or valve-gear and all the rest of it, without any feeling in the matter whatever, and steam engineering has been immensely benefited by it.

Artists, the most jealous of all people excepting musicians, criticise each other's work and submit to the irrevocable decision of a hanging committee, and how are we to improve our designs better than to submit to the condemnation of our bad work by others and applaud the good in theirs? It seems as if the question of whether cabinet work is an appropriate adjunct to a steam-engine or not could have but one answer, and still it goes on, and I really suppose it looks nice to most people when new and horrid to everybody ever after.

It would seem, after the example set by the Reynolds-Corliss, the Buckeye, and the German engines at Chicago, that we would soon see the last of it, and this leads me to the final step, the Columbian Exposition.

Through the kindness of the various builders I have been able to get a pretty accurate statement of the number, size, kind and power of the various engines of about from 100 H.P. and upward. The list does not comprise the small engines, of which, perhaps, there was 150 H.P. all told, nor does it include pumping, air-compressing, gas-engines, portable or semi-portable, of which no guess even has been made.

There were 29 single-cylinder engines aggregating 4,820 H.P., 47 compound engines aggregating 24,930 H.P., 5 triple-expansion engines aggregating 3,925 H.P., and 1 quadruple engine of 3,000 H.P., making in all 82 engines of a total of 36,675 H.P., exceeding the *Campania* by 7,000 H.P., making it likely the greatest aggregation of steam power ever assembled in so small a space.

Comparing the work of the present with that of 17 years ago, the Centennial with the Columbian, Chicago with Philadelphia, so far as the use of the steam-engine is considered, it is a change from single-cylinder to compound, triple, and quadruple-expansion, and the generation and development of the single balance valve, shaft governor, high-speed engine. But so far as the production of steam from the combustion of coal, the best of to-day is but little better if any than the best of 1876, nor is the average to any great extent better than then. Boilers have been improved, so that higher pressures are as safe to-day as the lower pressures, were before, and as more power is obtainable from high pressures than from low, to this extent has the modern boiler contributed its share to the improved economy. Water-tube boilers were wholly employed at Chicago, but that is no gauge as to what is the practice of the country, and only indicates the tendency which points as much toward higher pressures as it does toward the water-tube varieties, and the water-tube is gaining because of its ability to carry the high pressures.

An incredible amount of work has been expended on boiler and engine-room auxiliaries, some of unquestionable and much of questionable merit. Nothing has come to supersede the Worthington duplex steam pump, as its many copies confirm, wasteful as it is said to be in steam economy, and the various forms of steam injectors are mostly modifications of the original, and they hold about the same relation to the steam pump as they have for years. There are many new and many modifications of both single-acting and duplex pumps, and many modifications of the injector, mostly double, using the principle of the inspirator; but the main improvements have been in the simplifying of the number of handles to be operated, and in the devices that make the injector self-starting. Economy in the use of steam, either in the steam pump or injector, does not appear to have made much headway. At least, the more economical have not swept the old aside to such an extent as the automatic engine has superseded the slide-valve throttling sort.

Boiler feed-heaters have taken on new forms, with likely constructive and possibly with operative advantages, but with little strikingly new in principle, otherwise than where heaters and filters are so combined as to better rid the feed-water of its impurities before entering the boilers. Treating the water with chemicals and filtering is probably the most recent and advanced change that has been made.

Various new boiler compounds have been compounded, but what advance if any has been made is in a wider understanding, that the remedy must fit the disease. Just so far as compounds or filters prevent incrustation or contribute to keeping the boilers clean, just so much they have contributed to economy, and if all fixtures are credited with the saving claimed, they far more than make up for the increased boiler efficiency; so that boiler-makers may be falling back rather than progressing in the economy of steam production, though that is not likely.

Automatic damper regulators, high and low-water alarms, sediment pans, automatic boiler feeders, improved grate-bars, mechanical stokers, various steam and oil separators, and the steam loop have been studied over, changed, improved, perfected, or invented and applied during recent years; and these, too, in their way have contributed to steam economy, but in none has the change been more marked or results so advantageous as in the engines themselves.

Considering the engine exhibits at Chicago in the order of their magnitude, the 7,700 H.P. of Westinghouse, Church, Kerr & Co. was so far beyond anything ever before shown by one exhibitor as to set aside comparison. Their standard and compound engines, which have been on the market for a decade, call for no comment except that inspired by the wonderful growth of the industry. To install an experimental engine at an exhibition is a very risky thing to do; to install six experimental 1,000 H.P. engines of entirely new design, embracing untried mechanical devices, was a courageous one, and one that entitles the Company to as liberal consideration as the result requires to make the account stand on the creditable side. The new feature of air-spring to balance the weight of valve mechanism and at the same time to serve as starting-bar was as good a scheme as the many other good schemes shown by other builders.

The 3,000 quadruple Allis was too large for my comprehension, and I only raise the question whether the addition of the new feature to prolong the cut-off, and thus increase the range of power, is the best way to accomplish the result.

The Willans experiments tend to show, so far as an experiment with his style and that size engine can determine, that the superiority of automatic cut-off over throttling is less conspicuous on a compound than a single cylinder, and shows that there is very little or no economy at all in a triple-expansion. If this applies to all multiple-cylinder engines, then it may be possible that it is the best plan to reduce the valve-motion to the simple elements and govern by a throttling governor. If this will hold good in the case of the Allis engine, of course the same points come up in the Buckeye, Frazer & Chalmers, and others showing novel motions whose aim is in the same direction.

There is a more or less tendency to mix the shaft governor and Corliss valve, as shown by three or four different examples, the aim being to retain the good points of the Corliss valve and be able to run at higher speed. A promising scheme.

One word about the Bates drop motion. If it is as good as the detachable arrangement, then they can pride themselves on having something of their own; and while it does not place them above the first step on the Corliss monument, it puts them one step above those who only follow the original. I cannot follow out the list, noting every improvement each engine builder claimed; many good, perhaps one as good as another, and all worthy of a more extended notice than I am able to give them.

Among the marked novelties in engines—I mean a complete engine—that by Lavals, of Sweden, was one of the most conspicuous. Being myself the grand-nephew of a rotary engine, and this being a rotary engine, I speak as a relative, and venture to predict that, notwithstanding the 10,000 American patented rotary engines, this little Swedish bumble-bee of a thing is nearer seeing the daylight of success than any other before exhibited. While it employs the principle of a Pelton water-wheel, it possesses just those additional elements not in the Pelton wheel that make it a promising advance.

The Willans engine, while nearly as old as many well known American engines, is new to us and remarkable in many respects, but particularly for its economy in spite of what we have supposed to be detrimental features—throttling, single-acting, mechanically fitted valves, and high speed. But these defects, whether imaginary or real, are overcome or neutralized, and other advantages come in naturally, so that, while at first sight the claims for its economy are questioned, there is a lot of genuine steam engineering in it. Besides the low clearance, free escape for water, and no loss from compression, the main thing lies, I believe, in the fact that the steam end of

neither cylinder is ever in communication with the one of lower pressure or with the condenser. I spoke of the enormous growth of the Westinghouse; that of the Willans has been phenomenal—20,000 H.P. last year. We are prone to joke over the slow, conservative English; but perhaps they know a good thing when they see it, after all.

For great power in small space, the claim we make for our high-speed engines, it seems to me about an even send-off between the Westinghouse, Willans, and that crowning feature of the engine display, the triple-expansion 1,200 H.P. in the German exhibit. Personally I have not much to say about this engine, though I went by it several times a day for three months. It was never my good fortune to be there when they were making repairs, and so I could see no more than other visitors. Another engine of like power and occupying much more space and far more pretentious seemed to be in a chronic state of repair mostly.

Of all that was said at the previous meeting, nothing pleased me more than Mr. Holloway's remarks about the Creusot engine. It was not only by far the best piece of machine work I ever saw, but up to the present time I believe it would be utterly impossible to produce the like in this country, and for the same reason that we could not produce work like the "Venus de Medici" or Raphael's "Transfiguration."

As shown by the exhibits at Chicago, the standing appears in this way: The largest and most economical, and probably as economical as has been thus far built, was the Allis engine; the largest exhibit by any one firm was that of the Westinghouse, both American; the most economical high-speed engine the Willans, English; the best piece of steam engineering, the German; the best rotary, Swedish; and the best workmanship, French.

As to the future, I think we may look forward to using better judgment as to putting the right engine in the right place. There is a right and wrong place, if not for all, at least for several kinds. The claims against the high speed are that it is not economical, and terribly prone to smash-ups—claims pretty well founded; but, in spite of that, it has built itself up and was the means of building up the largest half of the electric-light business. As to its wasteful use of steam, that has been overestimated and is fast being improved; and as to the smash-ups, better separators and safety devices and the destructive fly-wheel accidents of the last two years of slow-speed engines put the boot on the other foot. With the high-speed engine and Mr. Porter came better work, and much better yet is needed and will be demanded, for there is a place for the high-speed simple engine that nothing else can fill. There is, too, a place for the Corliss engine and a place for the compound, though already many of them have been put in the wrong place; there is a place, and as yet a good deal of unoccupied space, for a vertical, direct connected machine, and places for the triple and quadruple-expansion. There is a show for better designs, a show for better workmanship, especially in castings; and as to the show for improvement in steam engineering, I can only reply, as Barnum did when asked what he thought his chances were for heaven. He said, "he thought he had the greatest show on earth."

DISCUSSION.

Mr. Cartwright: There is one feature Professor Sweet has spoken of which I heartily agree with. I am not connected with any engine works, but I have to use engines for different purposes, and when he says you may have the right engine in the wrong place, I think he says a great deal. That certainly has been my experience. My board of directors oftentimes say, "Why, Mr. Cartwright, you certainly will put in a Corliss engine." "No, gentlemen, I would not have a Corliss engine in that place. A Corliss engine is good where you are running 26 hours out of the 24 for the year right along, but I would not put a Corliss engine in where I was using it intermittently." I have one engine that in two years never has turned over but one-half day, but she did turn over when the call was made on her. A Corliss engine would not do that, according to my experience. You cannot lay up a Corliss engine as easily as you can lay up some others. I put in a Green engine. The professor did not bring in the Green engine, I believe, in enumerating the engines he spoke of. I think it is a very good engine. Mr. Sweet was at Chicago three months. I was going to say I was there three days, and of course I could not see as much as he did, but I did take off my hat to the German engine. I think it was the only engine on the ground there that was a first-class engine. When I asked these different parties why this was, they would say: "I will tell you, Mr. Cartwright. The foundation is so poor here that you cannot get in any engines." But you saw that German engine working there, and she did her work perfectly. I never saw a better exhibition of an engine in operation than she was, and I admired her thoroughly.

In relation to the big Corliss engine at the Centennial, it was a good monument. It was a very pretty picture, but it had a great many defects, as we afterward learned. They had two beautiful staircases up to the beam. Those staircases were not in the original design of the engine, as I understand it, but they were put up there to hold her up. They were put there as side-braces to take the lateral motion. The Buckeye took my attention at the Centennial.

Now I have just installed a plant for 4,000 H.P. I put in a Woodbury balanced slide-valve engine, and am perfectly satisfied with it—167 revolutions out of a 500-horse engine, and she does work magnificently. She will be an intermittent engine, because when we have no water we will call on the steam. We may have it for a year, and we may not have it for three months.

My experience with the Corliss engine is that it needs the doctor very often. We have handled a good many of them. The vibrating valve wears off. A Corliss engine cannot be repaired by any machine shop; it may be done, but special machinery is better. Take a Green engine, for instance; we have there all the advantages of the drop cut-off and the plain slide-valve. Mr. Le Van and I were boys together, and we did not have any machinery, and we took a hammer and chisel to do our repairs; but with a Corliss engine you have got to have special machinery to repair it properly.

Mr. Emery: By going off into a corner of the grounds, into the station of the Intramural Railroad, you would find a 170 kilowatt generator run by the Williams engine, a unique engine all the way through. It was of the marine engine type, but it was handling a generator very much heavier than the old-fashioned engine, and it would stand right up to its work, running 2,500 ampères, 560 volts there, slowing up when necessary, because it was not large enough to carry it, and then rising up to speed again. It ran the road without assistance from any other engine. It was a very creditable performance, and those who did not happen to see it missed something.

I was particularly impressed with the large number of engines with single valves, regulated by the governor, compounds and single engines, all working well. The high-speed engines had their troubles at first, and they were largely due to bad work. They were due to bad governing, and between the two there were considerable breakdowns, and there were hot bearings, and they were not popular; but those engines worked well, and a great many of them were fully loaded.

Mr. Odell: In regard to the Corliss engine at the Centennial, it probably was not of the best design, and it has been a subject of ridicule. But about that time, from 1872 to 1876, it was my good fortune to be very intimately acquainted with George H. Corliss. I did a great deal of testing for him, and those who know Corliss well, know that he always had some object in view in designing an engine. He designed that Corliss engine as an exhibition engine, and while he was building that engine he was designing an engine which has given about as good duty as anything from that day to this. I refer to the Pawtucket pumping engine.

Mr. Kent: The lesson of the engineering exhibit at Chicago to me was one of chaos. Steam engineering is undoubtedly undergoing a transition, and we do not know what it is going to eventuate in. There is a conflict between half-a-dozen types, and in each type there are half-a-dozen varieties. It looks as if in the next few years many of the engine builders of the country would be called on to revolutionize their shops and build a different kind of engine from what they are now building. We have heard encomiums of the high-speed small engine, running very high speeds and small powers. It looks as if the epitaph of that engine was very shortly to be written, because it has absolutely failed to demonstrate economy of steam. The slow-speed engines of the Corliss type are likely to be driven out to a large extent by the marine type of engine, and it is a question whether that is the coming type. There have been a great many criticisms made of the marine type of engine—that is, the three cylinders, cranks at 120, vertical engine—on account of its supposed instability vertically, the vibrations, the difficulty of climbing up-stairs to oil the engine, and all these things. Williams's exhibit also shows that there may be a change, and certainly makes the fly-wheel governor men a little alarmed by bringing back the possibilities of throttling governing again. Have we been making a mistake in saying that the throttling governor engine was a thing of the past? Shall we have to say that it is fully as automatic as the other when we put it on three cylinders?

Mr. Durfee: It may be of interest to the engineers present to know that prior to 1870 there were some Corliss vertical tandem engines designed by Mr. Griffin, and erected in the

Phœnix Iron Works. Those engines are still running, I believe. There was quite an interval of time between their erection and starting, through some change in the business, but the engines have given good satisfaction from the time they were put to work until the present. In 1861 I put a Corliss vertical engine, 42 × 42, running 85 revolutions a minute, in the North Chicago Mill. That engine I subsequently took out and put into the Milwaukee Mill in 1868. That engine is still running the rail train in the Milwaukee Mill. The last time I saw it it was making 85 revolutions a minute. I have never heard of any undue expense for repairs on that engine.

In about 1864 there was put into the Park Brothers' steel works—the Black Diamond Steel Works—several Corliss engines. One of them was of the same size and made from the same pattern that I used at the North Chicago Mill—42 × 42, upright. That drove a large plate train. I think it is still at work there.

As regards the Centennial engine, it may be of interest to hear the criticism of an English engineer on that engine. In 1885 I went to Chicago to attend a meeting of the Mining Engineers, I think it was, and with the party was Mr. John Jeers, of Middlesborough, England. I spent considerable time with him, and we went to Pullman with the rest of the party. Going into the engine-room Mr. Jeers was leaning on my arm. He never had seen this large engine, and really it looked about four times as large as it did at the Centennial. He held me back a moment and stopped and looked at that engine and said: "Mr. Durfee, that is the grandest engine I ever saw in all my life!"

Professor Hutton: What Mr. Kent says induces me to reminiscence and to confirmation of his feeling of uncertainty. In 1879 I was called on, as a sort of advisory engineer at Columbia College, to recommend to the Board of Trustees what form of engine we should put in to drive the ventilating fan of the building, which was then under construction. It was obvious that we wanted to have a high-speed engine, and Professor Trowbridge and myself agreed that the only engine that would meet the requirements of the case was the Porter-Allen engine, and there were several years during which all our class-room work was directed in that way. Mr. Porter could not furnish us with the engine when we wanted it, and the contractors went to the only other high speed engine that there was in existence at that time, and that was the Buckeye. That was only three years after the Centennial—by the time it was put in it was four years—and at that time there were but two high-speed engines; and when Professor Sweet was asked to give the opening paper at the formation of the Society, it was considered that it would be of great interest to have him describe to the American Society of Mechanical Engineers, just then formed, the special features of construction of his straight-line engine. That was a distinct novelty when this Society was formed only 14 years ago. When we consider that all this development of the modern engine, as we have seen it in Chicago, is the development of the last few years, we can appreciate how everlastingly rapid the development has been during that short time, and can concede that Mr. Kent's criticism is perhaps deserved, that we do not know exactly what is the future and stable type of the steam-engine.

I, personally, was very much struck with the remark made by Mr. George S. Strong at our meeting a month ago. Of course Mr. Strong spoke as a locomotive engineer, but he made this point: "Why in the world are the stationary engineers putting in power plants, proceeding on a very extravagant basis, which would strike a locomotive engineer as so very much beyond what is at all required?" That there is no reason in the world why one boiler should not be able to furnish the 1,400 H.P. that the locomotive is continuously able to deliver, and that from that one boiler and two cylinders we should be able to get upward of 1,000 H.P. for perhaps very little over $12,000. There is no one who does not talk of an electric light plant for $10,000, without at once thinking that means a good many boilers of the water-tube or other type and a very expensive engine, which in itself goes very near that sum of $10,000; and certainly we have, every time a 1,000 H.P. plant is designed, a figure that has much transcended the cost of a locomotive. If it be so, that the marine engine is a solution on land of the problem in that form, I think that there is a good deal for the engineer to learn in the direction of making a power plant of considerable magnitude for a little money.

Mr. Durfee: I remember seeing some years ago an engraving of a type of engine that is said to be quite common in England. I do not think it has ever been undertaken here. It is practically a semi-portable engine. There is a bed-plate of cast iron on which is mounted a locomotive boiler, a saddle under the smoke-stack end, and on each side of the saddle is a steam cylinder. The crank is just back of the smoke-box, and there are one or more fly-wheels on the outside of this bed-plate. The arrangement is as near as possible like that of the locomotive. I have been told that those engines are quite popular with those who have purchased them in England. The engine is capable of concentrating a very large amount of power in a very small space.

There was one remark more that I intended to make in regard to the Corliss engine, and that was in respect to the excellent work turned out under Mr. Corliss's administration. When I took this 42-in. cylinder engine from Chicago to Milwaukee I found that it was necessary to replace the dash-pots. They had got broken. I sent to Mr. Corliss for some castings, telling him that I would finish them at our works. To my surprise, the dash-pots came completely finished. Even the bolt-holes, 2-in. × $2\frac{1}{2}$, reamed bolts, were bored. The lugs for bolting them on to the frame were all planed off. I put some men to work on Sunday to put those dash-pots in position, and to my surprise when we got the stems of the dash-pots where they belonged, the planed finish of this lug was in contact with the corresponding part on the face of the engine, and I drove those bolts through with a mallet myself, screwed them up, and that was all there was to do to it. It is more remarkable when we consider that that engine was the first engine that Mr. Corliss had made off of those patterns.

Mr. Loring: Professor Hutton's quotation of Mr. Strong in reference to the use of the locomotive boiler and engine on land will recall to you, Mr. Chairman, perhaps, a little of the conversation that we had to-day, in which you confirmed the statement which I had made, that the locomotive boiler as built for locomotives has always been a failure when it has been attempted to use it on land or at sea. No man, I think, would be wild enough to propose to put a locomotive boiler, as it is constructed for railroad purposes, in use either for shop work or for the sea. There seems to be something in the peculiarity of the service to which the locomotive is put which enables it to do things which in the quiet of a shop or in the gentle motion of the sea makes it impossible to do. It is necessary, as you all know, either for land purposes or for sea purposes, to provide some method by which the ascending and the descending currents can be established, and by which the steam can escape readily from the tubes. This ability to disengage the steam at least is probably brought about by the vibrations of the locomotive upon the rails, by which the bubble of steam is detached immediately it is made. There have been repeated efforts to apply the locomotive boiler to marine purposes, with tubes far better arranged for circulation than they are ordinarily in the locomotive, and they have always been failures if they approximate at all the nature of the locomotive. I think there is no builder here who would dare to put the moderate quantity of bearing surface in the crank-pin that the locomotive carries. Whether it is the constant motion of the crank-pin in the open air that keeps it cool or not, I am not prepared to say; but those proportions would not do for a steamer, nor would they do on land.

In reference to the antiquity of certain engines which my friend, who has delved in antiquities, has mentioned to-night, I know of an engine that was completed during my apprenticeship. It was somewhere near 1848. That engine is still running in the American Tube Works, working their mandrels on the draw-bench, and what was known in those days as the grasshopper-engine—that is, it had a beam supported on one end of a vibrating beam, the crank being between this upright beam and the cylinder, and the rectitude of the piston-rod was controlled by a parallel motion. That engine, built in 1848 or 1849, is still running in the tool works, and without any material repair and no alteration whatever.

Mr. Durfee: Talking about antiquities, there was an engine put into the Baldwin Locomotive Works in 1836. It was put into those works by my father, and it was designed by Mr. Baldwin. Mr. Baldwin had a peculiar idea in regard to a stationary engine. He said that a stationary engine was not correct if the cylinder was horizontal; neither was it correct if the cylinder was vertical. His view was that the engine ought to be placed accurately at an angle of 45°, the main shaft being in the air and the cylinders down at the bottom of the inclined plane. Consequently this engine was put up in that way. A large brick foundation was built up the main shaft near the ceiling of the room, and the cylinder at the lower end. Another peculiar idea that Mr. Baldwin had was that the hexagonal guide-bar of all engines should be utilized as a feed-pump, and therefore the hexagonal guide-bar of that engine was made a hollow, and the plunger worked in the ends of it, which worked by an arm extending from the cross-head of the engine. The lower end of the bar had the usual valves. The last time I saw that engine, a few years ago, that pump was still working, feeding the boilers. The older members here will recollect that the early Baldwin locomo-

tives had similar feed-pumps and similar prismatic guide-bars.

Mr. Platt: Professor Sweet spoke of being at Battersea at the exposition of the Royal Agricultural Society of England. Agricultural engineering owes very much to that Society for the judicious way in which it has given prizes for excellence in agricultural engineering. Every few years they give prizes for certain branches, more particularly steam-engines, and the engineers had such confidence in the experts employed by the Society to conduct the trials, that they devoted themselves very thoroughly to producing the best things they could, and the result was that they raised agricultural engineering to the very highest point of engineering science. That has fallen into disuse somewhat, and many of the large makers are resting on their laurels; but now and again they give prizes, and it brings to the front some of the younger engineers; and notably at the last competition it brought to the front many new men who have since reaped the advantage of these trials.

Professor Sweet referred to steam plowing. That is still carried on to a very considerable extent in our country. Parties get engines and let them out to hire, or rather plow the land at so much per acre for farmers, and considerable business is done in that way.

Some one has referred to the locomotive boiler not being more generally used in stationary work. Well, some of you know that Mr. E. D. Leavitt used the locomotive type of boiler very much for some of his work; but you will bear in mind that it is usually continuous work—that is, they work day and night, and that is one great advantage in locomotive boilers, to keep the boiler always at work. That is the difference between the American and the English locomotive. You can use steel fire-box plates in America, and we cannot use them in England, because you run your locomotives day and night with two sets of men, and ours are only run days. They go into sheds at night and cool down, and I think that is one great reason why steel boxes won't stand with us, and another reason is that our boilers are more rigid. They are stronger and better stayed and not so elastic as the American build of boiler.

Some one remarked as to using the marine type of engine more extensively for land purposes. There has been a tendency in that direction in England. Many large factory engines have been erected of that type, some of them running very considerable piston speeds, but they do not run so comfortably as the horizontal engines of longer strokes. There is a good deal of trouble with the packing boxes. The grit and dirt work down into the gland, and that, I believe, is the principal trouble they find in England. Hick Hargraves have erected some very fine examples, but still they stick more generally to their horizontal compound type and are making some very large powers.

Mr. Le Van: I had the pleasure on Monday of looking at an engine built in 1819. The engine had run up to 1885, and it was only superseded on account of being too small. It was a low pressure engine.

Mr. Kent: It strikes me as singular that so young a man as I am can go beyond Mr. Le Van and Mr. Durfee, but in *Engineering News* you will see a drawing of an engine running in Savannah, Ga., built in 1815 by Bolton & Watt, imported from England. It is really a remarkable engine. It is 30 ft. long on a horizontal line, 6-ft. cylinder, 31 in. diameter, beam about 18 ft. long, and running, I think, 18 revolutions a minute with 8 lbs. pressure, and developing 90 H.P.

Mr. Cartwright: I happened to be engineer of an establishment that had one of old Oliver Ames's engines, and I saw her running. It was built 1808. I have said before, and have been laughed at, that the modern engine as built to-day has more good machinery that is spoiled by being over-fitted than all that has been under-fitted. I had an engine some eight or 10 years ago—a Corliss engine—and she was a splendid piece of work. I had charge of the establishment for some three months. One day I came over to New York, and the whole establishment was stopped. The engine had melted the babbitt out of the bearings. I said I could fix her, but the president would not let me. He sent to Mr. Harris, who sent his Mr. Babbitt down, who agreed with me, but said that Mr. Harris is a stickler for fine fits. Periodically she melted her babbitt out. She did it once when I was alone and I fixed her, so that she has been running nine years and has not stopped since. All I did was to take one-tenth of an inch off her crank-shaft. Now that character of work spoils more work than all this loose fitting does. I want to have a fit, but I do not want to pinch things. I have seen traveling cranes built that developed more power to turn them over when they had a load on than the whole thing would run with if she had a chance to go and come. I will show you to-day drawings of a man-of-war that was built in 1848. She had a trunk engine. Now no one would think about making a trunk engine to-day; but it was good in its place. You had to get all the machinery below the water-line. We had not got on to those back action grasshoppers that we had during the war. Why is it that after we put the marine engine on board a ship that we have to make her so excessively heavy? The reason is that she is bearing here one instant and there the next. Look at the big crank-shafts, how easily they are broken! It is because of the undulations. It is just like bending a piece of tin. You take a stationary engine, put it on a good foundation, and with good care of the engineer it ought to run forever.

Dr. Emery: The remarks of Professor Hutton make it appear to me very proper to mention the originator of the high-speed engine with a single valve. I refer to our late lamented associate, John C. Hoadley. I think any one who will go over the facts will realize that such is the case. We had the hog motion, as it was called, the sliding of the eccentric across the shaft, long before his time, and it was therefore known that that was applicable; but the first instance that I recollect of an engine that worked properly, that was the prototype of the present high-speed engine, was exhibited by John C. Hoadley at the Centennial Exposition. He was building a line of portable engines with locomotive boilers and the engine of that type mounted upon it. He had there the present modern spring governor, well proportioned to give good regulation, and he had the piston-valve, and in a test of that engine it ran down to 26 lbs. to the H.P., high pressure, non-condensing, or below the tests I have made of engines developing the same power of the Corliss type. That was in 1876. Many may not know that his draftsmen were Armington & Sims, and that their work followed his. He got into financial difficulties, and they took the shop. I think, however, that their work did not come out until after the Buckeye mentioned by Professor Hutton. In the Centennial report you will find the success of that engine recorded, and I think to him should be given that credit.

Mr. Platt: I do not know whether it is over-fitting or what that we have to look to, but certainly I was surprised at the number of hot bearings and breakdowns that took place at the Chicago Exposition. From the first right through to the end we were continually seeing engines of one kind and another stopped; bearings hot, cylinder heads blown out, and one thing and another was constantly going on. It was something that ought not to have been seen in an exposition of that kind. Just where the reason is I do not know. I was in Hicks & Hargraves' place in England a year or two ago, and they had then six or seven large engines, up to 2,000 or 3,000 H.P., vertical. I noticed that they paid great attention to the crank-shaft bearings. They were all made a big swivel bearing. They used also a great deal of steel in the framing. But I know that they considered that a good deal of trouble had taken place in those big engines with the crank-shaft and crank-shaft bearing, and they had designed this bearing to get over the difficulty. They seemed to have great success with the engine, and I know of building a number of them for electric-lighting purposes. We were speaking of the questions of bearings heating and the question of end play. Now the firms in the north there always allow one-eighth of an inch, and even more than that, end play in the main bearing and the crank-shaft bearings, too, and they never get hot while they wear forever. I know engines that have been put up inside of two or three days at a big mill and started up, and then they will go on working, and perhaps it will be six months before the engine stops.

Mr. Bitts: In regard to old engines, I am rather surprised that no one has referred to an engine that was shown in 1876. The first engine which was ever put to work in this country was a pumping engine, which was at the Schuyler copper mines at Arlington, and parts of which exist, I think, at this day, and were until very recently to be seen at Newark.

Mr. Forney: I have listened to the discussion this evening with a great deal of interest, and it happens to me, as it happens to most other people, that I am very apt to look at subjects through the spectacles I am in the habit of wearing. For a good many years I have been in the habit of looking at steam-engines only as they are applied to locomotive purposes. There has been a good deal said this evening about the defects and the deficiencies of stationary engines, which somehow seemed to me to have been solved to a considerable extent in locomotive engines. We have heard this evening about the high-speed engine, which was introduced, I believe, in the first place, at the Centennial. It seems to me if we refer to locomotive practice we will find that high-speed engines were used as locomotives a great while before the Centennial Exposition. I think we might go back even to the time of the *Rocket*, and find that that was a high-speed engine. So that,

as far as the problem of high speed is concerned, it strikes me that it was solved in locomotive practice long before 1876.

Now there are a good many other problems which come up to locomotive men. It is not only a question of high speed, but it is also a question of slow speed. Such engines must be built to work at the very slowest speed at the maximum capacity that it is possible for them to exert, and then gradually increase the rate of work and the amount of power developed, until you reach speeds of 60, 70—some men are sanguine enough to say 80 miles an hour. Such conditions are very different from the conditions under which a stationary engine or even an ordinary marine engine must work. The power developed in a locomotive boiler differs immensely from that developed in a stationary or marine boiler. Some experiments made on the Baltimore & Ohio Railroad, on the heavy grade over the Allegheny Mountains, showed that they burned 196 lbs. of coal per square foot of grate per hour. As there are about 20 sq. ft. of grate on an ordinary locomotive boiler, that means they burned about 4,000 lbs. of coal per hour; and as they would evaporate about 6 lbs. of water, it is not a difficult matter to get at the amount of work done by that locomotive in that period. Some tests show that they have burned over 200 lbs. of coal per square foot of grate per hour. I think it would be very difficult to find any other type of boiler which does a corresponding amount of work.

Commodore Loring this evening has told us that no one would dare to place a locomotive boiler either in a ship or in a stationary engine and expect it to do the great amount of work done in locomotive practice, and apparently he attributed that difference in the operation of the locomotive boiler to the fact that it is working under a certain amount of tremor during the whole period of its active exertion. It seems to me that if that is the fact, if the difference in the working of a locomotive is attributable to that fact, it would be a wise thing to apply a sort of Swedish movement cure to a locomotive boiler, and keep it in a constant state of tremor while at work. The secret of that, it strikes me, must be somewhere else. At any rate, it is worthy of very careful investigation to see how much the superior efficiency of locomotive boilers is due to that tremor or the roughness of the track.

You have also, no doubt, heard a great deal about the difficulty they are having in the English Navy in keeping tubes tight. I have asked the question a good many times as to whether in marine boilers they use copper ferrules on the ends of their tubes, and I find that practice is not at all general. In locomotive practice it is almost universal now to fit the fire-box end of the tubes with a copper ferrule on the outside of the tube, between it and the tube-sheet, and then caulk it up over that. I think no locomotive man who understands his business would dare to put steel or iron tubes into a locomotive without putting in a copper ferrule.

Furthermore, we have heard that locomotive crank-pins are made of such a size, that no one would dare to imitate that practice in a marine or stationary engine, and that fact is attributed to the circumstance that the locomotive crank-pin is revolving at a very high rate of speed in the open air, and is thus cooled down in the current of air to which it is exposed. If that is true, it strikes me as a very simple expedient to put on a blower and blow on to the crank-pins and keep them cool. Another gentleman has spoken of the difficulty of keeping the shafts of marine engines in a state of integrity. We find the locomotives running at these high rates of speed over tracks of every degree of roughness and of smoothness, running by day and by night, in the cold and in the wet, and still our shafts are not constantly breaking. Then another gentleman has said this evening that a great deal of difficulty arises from the fact that we have too much good fitting; that our engines are built too well; that we do not allow end play. Now those bad things seem to exist in locomotive practice. If we do not allow end play, the working of the locomotive very soon provides it for itself, and our great trouble is to keep them from having end play. It, therefore, would be perhaps advisable to shake up ordinary stationary engines and marine engines, so that they would give more of this end play that is so desirable. I think there are a good many things worked out in locomotive practice which it might be well to look into, and find out just what the principles are which enable us to do things in locomotive work which cannot be done in stationary and in marine work.

Mr. Cartwright: In regard to copper ferrules for a marine boiler, we all know what salt water does with copper in a boiler. It will cut the iron very quickly.

The Chairman: The subject of the next meeting will be Testing Machines and Tests of Materials, and an introductory address will be given by Mr. J. Sellers Bancroft of William Sellers & Co., of Philadelphia, describing the recent improvement in the Emery system of testing machines.

APPARATUS FOR RAPID LOADING OF COAL INTO SHIPS.

By G. Braet.

(*Continued from page* 119.)

Lifts of the Bruay Mining Company, Calais.—This company has its loading basin located at the north of Bethune, and is in communication with the canal of Abie a la Basse. The loading wharf has a railroad communication with the mines; it is provided with two hydraulic lifts located at a fixed distance from each other, so as to be able to place a boat that is to be loaded under the hoppers of each of the apparatuses. The hydraulic lift is composed of a platform placed central with the railroad which runs parallel to the wharf. The cross-bars of iron at the ends of the platform are turned up vertically and serve to support the two trunnions which are carried by cast-iron supports. The upper part of these vertical portions are provided with an endless screw, which is used to draw in or set out the two blocks which serve to hold the body of the car during its period of inclination. Below the platform there is an ordinary hydraulic lift, which receives its water from an accumulator. The piston of this hydraulic press is connected to the platform by means of two intermediate connecting-rods.

The hopper which is used to carry the coal from the car into the boat is trapezoidal in form. The longest side is equal to the length of the body of the car, and the opposite end on the basin side is narrow, so that it can enter the end openings of the boats of average capacity. The end of this hopper or shute has a special arrangement which permits it to hold the coal in the shute and to distribute it at all points along the boat. The handling of this end of the hopper is done by means of a crab with an endless screw. The upper part of the hopper is formed of a movable table pivoted on the vertical supports of the platform, and which rest on the hopper, properly speaking. This movable table follows the motion of the platform. The hopper is carried by a shaft resting on two blocks fastened to the wall of the wharf; by means of the crab *K* it can be moved horizontally for the purpose of accommodating it to the easy handling of the boats. This crab also serves to regulate the inclination of the hopper so that the coal will slide over it freely.

The apparatus is worked in this way: An ordinary car full of coal having been run on the platform, as shown in the figure, the blocks are brought out against the side of the body, and then the side doors of the car are opened; at the same time a cock is opened which admits the liquid from the accumulator into the hydraulic ram. As soon as the cock is opened the platform and the car rise, turning about the trunnions; the doors of the car, which are swung from the upper portion of the body, swing out naturally as the car is inclined, and the coal runs slowly into the hopper, whence it falls into the boat at a slow speed. The raising of the car is then continued until the floor has an inclination of about 32°, which is sufficient to cause the coal to run out. When the car has been completely emptied the platform is dropped back again and another run upon it. The body of the car consists of a single box which has a capacity of 10 tons.

With a single apparatus of this kind the Bruay Company unloads about 70 cars a day. The greatest rapidity which has thus far been obtained is five cars in ten minutes. Such an apparatus will cost about $2,100.

The Coal-Handling Frame of the Noeux Company (*Pl. VII*).—The tracks of the coaling station are connected with the unloading wharf which is built along the docks of the company, that are also connected with the Canal of La Bassée à Aire. The fixed hopper is composed of a structure formed of two ribbed cast-iron cheeks solidly bolted to the wall of the wharf and carrying on their upper end a crab for handling the movable shute. The bottom of the hopper is made of plate iron, and stands at an angle of about 24°. The movable shute is connected with the fixed hopper by a neck or distributor which can be put in any position about a vertical axis, and which thus serves to distribute the coal over the whole of the circumference which is thus described. The chains which carry the end of the shute run over sheaves, and then come down to be wound up on drums of the crab. In order to balance the weight of the whole the two drums are keyed to the same arbor on the crab and are provided with chains which carry counterweights traveling up and down in the vertical wells which are built into the wall of the wharf. In order to reduce the weight of the moving parts as much as possible and to guarantee their strength and durability, the shute and distributor have been made of sheet steel, and the gearing, the

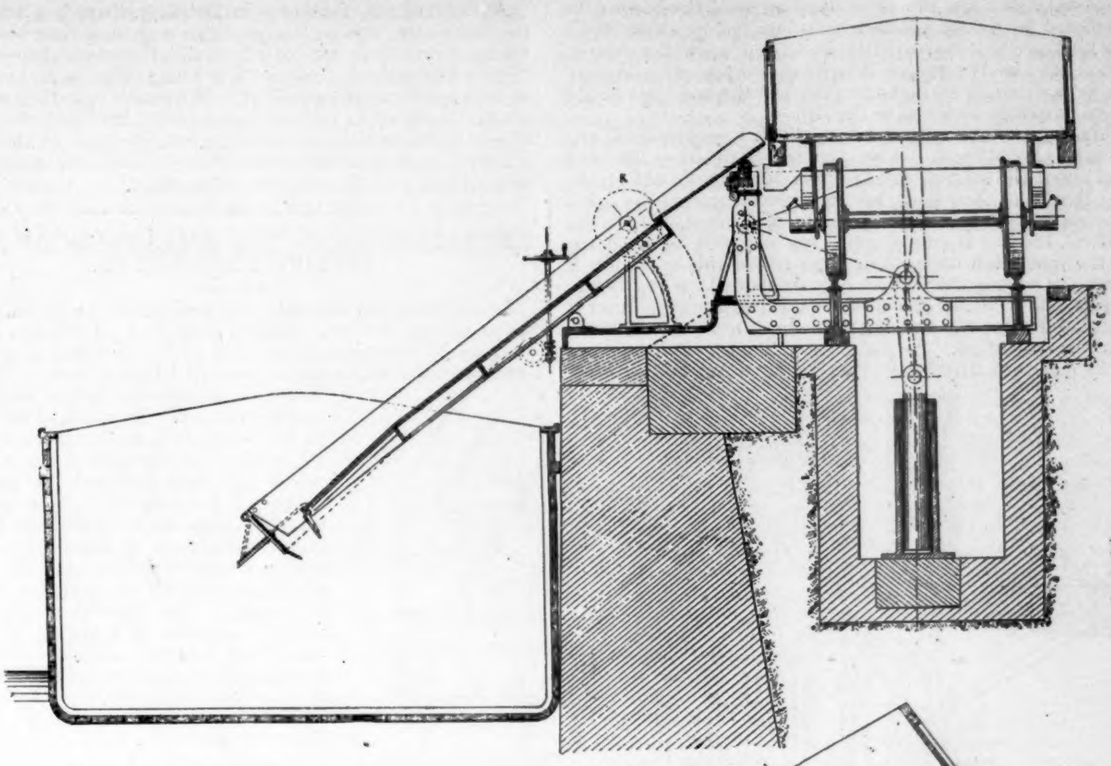


Fig. 9.

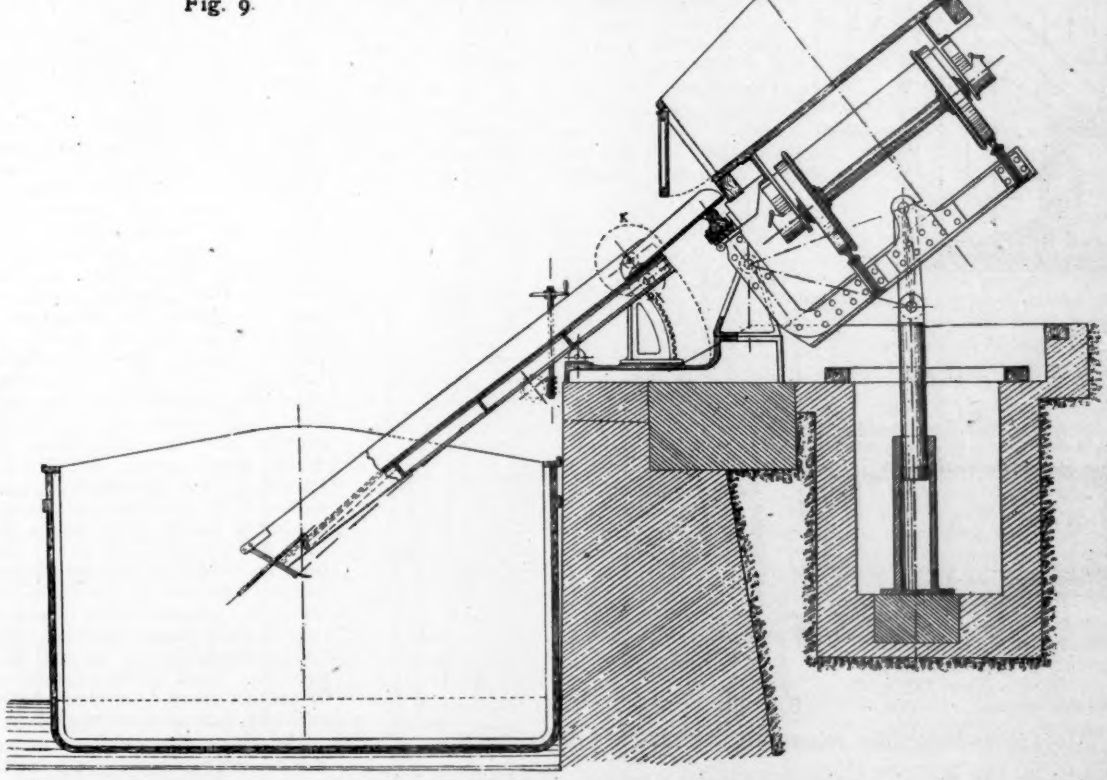


Fig. 10.

LIFT OF THE BRUAY MINING COMPANY, CALAIS, FRANCE.

bevelled pinions, and the sheaves of cast or forged copper. The rotating movement of the neck is obtained in the following manner: The neck has a toothed cap which meshes in with a bevelled pinion keyed on the same shaft as the wheel, and driven by an endless chain. This crown gear is guided by sheaves carried on a circular and grooved piece bolted to the rounded end of the shute. In order to handle the apparatus the workman takes the wheel of the crab in his hand and thus raises or lowers the shute and turns the distributor by means of the endless chain. The inclination of the shute can be varied from 20° to 32°.

The cars are made entirely of iron. The excess of weight is compensated for by the greater durability and strength of form over that obtained in wooden cars. Each car is composed of a truck carrying three boxes of sheet metal strengthened by angle irons and other special forms. Each box has a capacity of 3½ tons. They have two strong hinges, about which they can turn and be given such an inclination as is desirable on the

longitudinal sills. On the sides standing next the hopper the box is closed by a door pivoted horizontally and engaging in clips which are fastened a little back and upon the ends of the car. At the bottom of this door two pins are fastened which work laterally and are caught when the box rests on the truck by two dogs attached to the sill.

In this way an automatic opening, which is very reliable and very simple, is obtained. When the box is raised at the back it turns about the hinges, and the pins on the door are gradually set free from their dogs, and at a given moment the opening is completely free for the passage of the coal. If, on the other hand, the box is empty and it has dropped back on the track, the pins catch under their dogs before this operation is completed in consequence of an eccentricity which is given to the pivots about which the door swings, so that the latter is tightly closed when the box has come back to its normal position for transportation. At the Noeux Station the boxes are raised by means of a hydraulic ram which moves in a cylinder

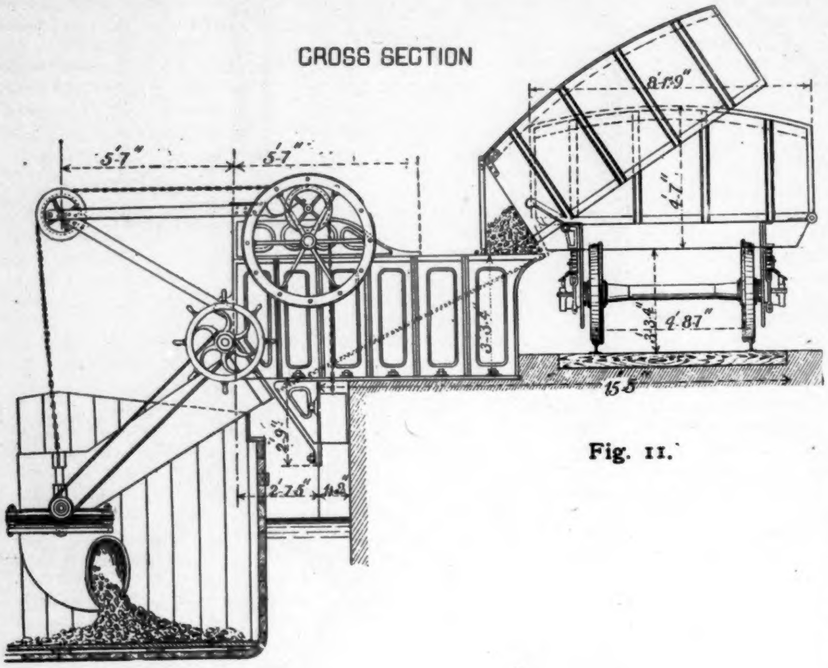


Fig. 11.

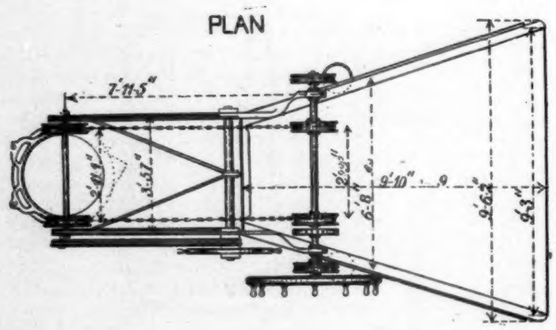


Fig. 12.

COAL-HANDLING FRAME OF THE NOEUX COMPANY.

oscillating about two trunnions; the water under a pressure from an accumulator is let into this cylinder by a cock. Some engineers prefer the oscillating method to a fixed method as being more simple and transmitting more useful power without the use of connecting rods. At the loading wharf the boxes are raised by an ordinary crane.

In Germany, in the basin of the Ruhr, especially at Ruhrort, there are some tilting arrangements which tilt by weights, and which work very well. But we prefer tumblers delivering coal on one side, as they require lass attention to haul the wagons in and remove them again. In other respects these tilting cars are of a construction similar to that which we have just been speaking about, and are handled in the same way; hence we will not stop to discuss them further at this point.

At Seraing and Yemeppe, in Belgium, there is a tumbler of the same kind as that which we have just spoken about, but whose working is not entirely satisfactory, and leaves something to be desired. As we have seen, there is no agreement as yet as to the best method of loading coal, but when we have given the situation, the amount of traffic, the kind of coal, and other matters which are to be loaded, the type of the rolling ing stock and the motive power at our disposal, we can then make a choice of the best system to adopt.

EXPERIMENTS ON THE EXPANSION OF LOCOMOTIVE FIRE-BOXES.

In 1892 some experiments were undertaken at the Batignolles shops of the Western Railway Company of France, for the purpose of determining the kind and importance of the relative expansion which takes place in different parts of the fire-box of a locomotive boiler while it is under pressure. An attempt was made at the same time to determine whether the method of supporting the fire-box, which had been adopted for the new high-speed engines of the Western Railway Company, would lend itself readily to the movements of these expansions, and especially maintain itself in a firm position during all the normal conditions of running. The bracing which is referred to consists of a system of transverse bars attached to the fire-box by screws, and resting freely at their ends on horizontal brackets riveted to the outside of the shell, as shown in fig. 1. When the fire is first lighted the fire-box, which is of copper, expands slightly under the direct action of the flames, while the outer shell, which is of iron and which is only heated slowly and follows the variations of the temperature of the mass of the water, expands very little and very much more slowly. The fire-box thus first rises relatively to the outer shell. It is very important, then, that this rising can be made freely, for every resistance which tends to oppose it strains the tube sheet and tends to make the holes oval. In the system of bracing which is indicated the crossbars are not fastened to the brackets, and can thus easily rise from them without in any way interfering with the movement of the crown sheet. But it is also of equal importance that the fire-box should not run suspended in this way when it is in service, for if it should the running vibrations would strain the stay bolts very greatly, and the continuous shaking which would result would soon cause cracks or even breakages in these staybolts. It is, therefore, very essential in fire-boxes under consideration that the cross stays should rest firmly on their brackets before the standard pressure is reached, and that in the limits between which the pressure varies in services the contact shall remain established, guaranteeing the rigidity of the fire-box while running. Both of the experiments undertaken were to determine whether this condition had been entirely fulfilled.

The boiler with which the experiment was made was removed from the frames, and the mud-ring rested at its center point upon foundation which was absolutely rigid. The shell of the boiler was also held at the front end, and as a displacement of the fire-box would have falsified the results of the experiments, a greased sheet was placed under the smoke-box to facilitate the movements of the expansion which might be caused at the front end.

The vertical expansions of the fire-box were measured directly in the following manner: Two steel rods were screwed into the top of the crown bars at the extreme front and back end of the fire-boxes, as shown in fig. 2, and their upper extremities came out of the shell through stuffing-boxes. Fig. 3 gives a detail of this arrangement. At the top of the boiler and near the end of the rods two horizontal scales were fastened independently of the boiler. The variations in the posi-

tions of the end of the rods, and consequently of the fire-box, were thus traced on these scales by means of a gauge point. By setting two gauges into prick punch marks *L L'*, which were made in the outer shell of the fire-box near each of the two gauge-rods already referred to, the variations in the position of the outer shell could be traced on the same scale. This arrangement permitted the simultaneous measurement at any point in the experiment of the vertical expansions of the fire-box and its outer shell, and to follow their relative movements. In addition, the expansions of the outer shell were measured while steam was being raised in a vertical and transverse direction. The vertical expansions were measured in two planes

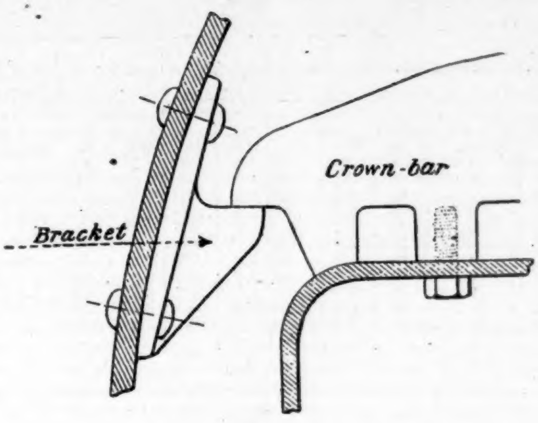


Fig. 1.

S and *S'*, fig. 2, perpendicular to the axis of the boiler and passing through the axis of the rods attached to the crown bars. The intersections of these planes with the external surface of the fire-box was also traced. Four points, *O*, *O'*, O_1, and O_1', were then marked on these two lines at the height of the center of the ring, and four points, *A*, *A'*, A_1, and A_1', at the height of the plane of contact of the crown bars and the brackets; each of the lengths, *O A*, was divided into four equal parts at the points *a*, *b*, *c*, etc. The points *O*, being at

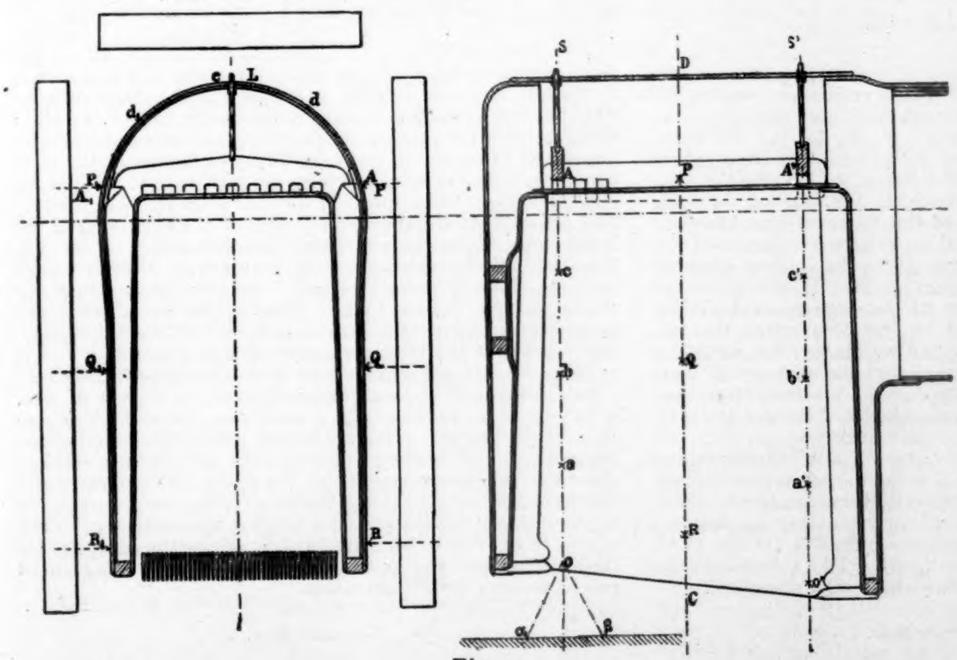


Fig. 2.

the height of the mud-ring, were taken as a base of the vertical expansions. The variations of the intervals, *O a*, *O b*, etc., were measured during heating by means of two gauges having, when cold, the original lengths of *O a*, *O b*, etc. As for the arcs, *A* A_1, *A'* A'_1, of the fire-box, fig. 2, they were divided into four equal parts, and the variations of the intermediate arcs were measured by means of a two-point gauge made in the same way.

The transverse expansions were measured in the vertical plane *C D*, fig. 2, drawn at right angles to the axis of the boiler through the center of the interval which separates the two end crown bars. On a line determined by the intersection of this plane with the external surface of the fire-box the following points were marked: *P*, P_1 at the height of the brackets, and *R*, R_1 about 4 in. above the ring. *Q*, Q_1 at the center of the interval which separated these other two points. Two vertical scales were fastened to each side of the fire-box and opposite the points *P*, *Q*, etc., and scales of the small plates of zinc were placed, upon which the movement of these points was traced by means of one-point gauges.

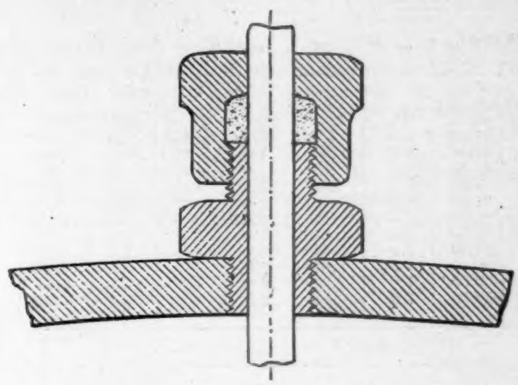


Fig. 3.

Before beginning the heating, the fire-box was carefully examined in all parts to determine whether its walls, and especially the crown-sheet, had not been subjected to some deformation which could falsify the results of the experiments; the side sheets were found to be perfectly flat, and the crown-sheet was not distorted in any way. They then made sure that there was an absolute contact between the crown bars and the brackets which carried them. Finally it was necessary to be sure, at all times during the experiment, that the position of the ring of the fire-box, which was the base of all the measurements, remained stationary. For this purpose the distances of each of the points *O*, from two fixed points *α* and *β*, were established by one-point gauges having the length *O α*. The intersection of the two arcs of the circles described from *α* and *β* with *O α* and *O β* for radii fixed a point corresponding to the initial position of the point *O*. It was therefore very easy to determine the displacement which the point *O* had been subjected to. By means of gauges fixed in this way a trace of the pistons corresponding to the different temperatures when cold could be observed. The fire was lighted and the temperature steadily raised. The variations of the fire-box and of the outer shell were traced simultaneously every five minutes, until the pressure of the steam had risen to 14 lbs. per square inch. Starting from this pressure, the expansions of the different parts of the fire-box were taken at each rise of 1 kg. (14.19 lbs.) in pressure. The pressure of 1 kg. (14.19 lbs.) was reached 45 minutes after lighting the fire; the test was carried on until a pressure of 11 kgs. (156 lbs.), corresponding to the working pressure of the boiler, was reached. This maximum pressure was reached in 1 hour, 45 minutes after lighting the fire. The positions of the points *O* and *O'* having been verified during the rise in pressure by

means of the gauges $O\ a$, they found that during the whole of the test the ring of the fire-box had been subjected to no variation which could falsify the measurement. The points O and O'_1 were slightly moved at the pressure of 11 kgs. (156 lbs.) by about .04 in. toward the front, and the points O and O_1 by about .08 in. toward the back, but each of these two points remained in the same horizontal plane.

Vertical Expansions of the Shell.—The following table gives the value of the vertical expansions of the shell taken at each kilogram of pressure :

The results are represented graphically by the curves of fig. 5. These curves are constructed in the following manner: On the axis $O\ x$ three points, $P\ Q\ R$, equidistant from each other, are taken; then upon the ordinates of these points lengths proportional to the values observed for the displacements of the points $P\ Q\ R$, on a pressure of 1, 3, 6, and 11 kgs. per square centimeter (14.22, 42.57, 85.14, and 156 lbs. per square inch), were laid out. The points obtained were then united by a continuous line, and the curves thus traced can be considered as representing approximately the transverse expansions of the line $P\ Q\ R$, fig. 2, at each of the pressures indicated above.

RIGHT SIDE.

FRONT.

Pressures.		$O'\ a'$		$O'\ b'$		$O'\ c'$		$O'\ A'$	
Kil. per sq. cm.	Lbs. per sq. in.	Mm.	In.	Mm.	In.	Mm.	In.	Mm.	In.
1	14.22	0.3	.010	0.7	.028	1.1	.043	1.5	.060
2	28.44	0.5	.020	1.0	.040	1.5	.060	2.0	.080
3	42.67	0.6	.024	1.2	.050	1.8	.070	2.4	.090
4	56.89	0.7	.028	1.4	.055	2.1	.080	2.9	.110
5	71.08	0.8	.030	1.6	.060	2.4	.090	3.3	.130
6	85.33	0.9	.035	1.8	.070	2.7	.100	3.7	.146
7	99.52	1.9	.035	1.9	.075	2.9	.110	3.9	.153
8	113.80	1.0	.040	2.0	.080	3.0	.120	4.0	.160
9	128.00	1.0	.040	2.0	.080	3.0	.120	4.0	.160
10	142.00	1.0	.040	2.0	.080	3.0	.120	4.0	.160
11	156.00	1.0	.040	2.0	.080	3.0	.120	4.0	.160

BACK.

Pressures.		$O\ a$		$O\ b$		$O\ c$		$O\ A$	
Kil. per sq. cm.	Lbs. per sq. in.	Mm.	In.	Mm.	In.	Mm.	In.	Mm.	In.
1	14.22	0.4	.016	0.8	.030	1.2	.050	1.7	.067
2	28.44	0.5	.020	1.0	.040	1.5	.060	2.0	.080
3	42.67	0.5	.020	1.2	.050	1.7	.067	2.3	.090
4	56.89	0.6	.024	1.3	.050	1.9	.075	2.6	.100
5	71.08	0.7	.028	1.4	.055	2.1	.080	2.9	.110
6	85.33	0.8	.030	1.6	.060	2.3	.090	3.2	.130
7	99.52	0.8	.030	1.7	.067	2.4	.090	3.3	.130
8	113.80	0.9	.035	1.7	.067	2.5	.098	3.4	.134
9	128.00	0.9	.035	1.7	.067	2.5	.098	3.5	.140
10	142.00	0.9	.035	1.7	.067	2.5	.098	3.5	.140
11	156.00	0.9	.035	1.7	.067	2.5	.098	3.5	.140

LEFT SIDE.

FRONT.

Pressures.		$O'_1\ a'_1$		$O'_1\ b'_1$		$O'_1\ c'_1$		$O'_1\ A'_1$	
Kil. per sq. cm.	Lbs. per sq. in.	Mm.	In.	Mm.	In.	Mm.	In.	Mm.	In.
1	14.22	0.5	.020	1.0	.040	1.5	.060	2.0	.08
2	28.44	0.6	.024	1.2	.050	1.8	.070	2.4	.09
3	42.67	0.6	.024	1.3	.050	1.9	.075	2.6	.10
4	56.89	0.7	.028	1.4	.055	2.1	.080	2.9	.11
5	71.08	0.8	.030	1.6	.060	2.5	.098	3.2	.13
6	85.33	0.9	.035	1.7	.067	2.5	.098	3.5	.14
7	99.52	0.9	.035	1.8	.070	2.8	.110	3.8	.15
8	113.80	1.0	.040	1.9	.075	3.0	.120	4.0	.16
9	128.00	1.0	.040	2.0	.080	3.0	.120	4.0	.16
10	142.00	1.0	.040	2.0	.080	3.0	.120	4.0	.16
11	156.00	1.0	.040	2.0	.080	3.0	.120	4.0	.16

BACK.

Pressures.		$O_1\ a_1$		$O_1\ b_1$		$O_1\ c_1$		$O_1\ A_1$	
Kil. per sq. cm.	Lbs. per sq. in.	Mm.	In.	Mm.	In.	Mm.	In.	Mm.	In.
1	14.22	0.4	.016	0.9	.035	1.6	.060	1.8	.070
2	28.44	0.5	.020	1.0	.040	1.6	.060	2.1	.080
3	42.67	0.6	.024	1.2	.050	1.8	.070	2.4	.090
4	56.89	0.6	.024	1.4	.055	2.0	.080	2.7	.100
5	71.08	0.7	.028	1.5	.060	2.1	.080	2.9	.110
6	85.33	0.8	.030	1.6	.060	2.3	.090	3.2	.130
7	99.52	0.8	.030	1.7	.067	2.4	.090	3.4	.134
8	113.80	0.8	.030	1.7	.067	2.5	.098	3.5	.140
9	128 00	0.8	.030	1.7	.067	2.5	.098	3.5	.140
10	142 00	0.8	.030	1.7	.067	2.5	.098	3.5	.140
11	156 00	0.8	.030	1.7	.067	2.5	.098	3.5	.140

The result of column 4 of each of the above tables is represented by the curves of fig. 4. These curves are constructed by taking the pressures for the abscissas and the expansions of the length $O\ A$, $O_1\ A_1$, $O'\ A'$, $O'_1\ A'_1$ for the ordinates. The points O having been taken at the height of the center of the ring, and the points A at the height of the plane of contact of the crown bars and the brackets, the four curves represent the vertical displacement of the four extreme brackets, since, as has been stated, the points O were not displaced vertically. Thus the full-line curve gives the vertical displacement of the extreme front bracket on the left, and the dotted curve the vertical displacement of the extreme back bracket on the left, etc. It has, furthermore, been stated that the arcs $A\ A_1$, $A'\ A'_1$ did not expand regularly; the variations observed for the four equal arcs in which each one of them had been divided was exactly the same. The maximum variation measured for each of these small ordinates was .05 in. for a pressure of 156 lbs. to the square inch.

Transverse Expansions of the Outer Shell.—The expansions measured in the vertical plane $c\ d$, fig. 2, and at three points, $P\ Q\ R$, was determined, as has already been described. They were only taken at four intervals corresponding to pressures of 1, 3, 6, and 11 kgs. per square centimeter (14.22, 42.57, 85.14, and 156 lbs. per square inch). The following table gives the values of the expansions which were observed :

Vertical Expansions of the Fire-Box and the Outer Shell.—The fire-box expanded rapidly at the beginning of the test; five minutes after lighting the fire these expansions had already amounted to as much as .01 in. The variations of the shell were very much slower, and they did not begin to be appreciable, showing .006 in., until 20 minutes after lighting the fire. Nevertheless, during the whole period of the beginning of the heating, the variations were taken simultaneously for the fire-box itself and for the outer shell, at intervals of five minutes until the steam pressure reached 1 kg. per square centimeter (14.22 lbs. per square inch). Starting from this point, the measurements were taken only at intervals of time corresponding to a rise of 14.22 lbs. per square inch in pressure.

Table No. III. gives the values found for these variations.

The results are shown graphically and by curves of figs. 6 and 7. The curves of fig. 6 show the comparative expansions of the fire box on the outer shell during the period of the beginning of the heating—that is, until the pressure reached the 1 kg. per square centimeter (14.22 lbs. per square inch). They are laid out by taking the time for the abscissas and the expansions at five-minute intervals for the ordinates. The curves of fig. 7 have been obtained by taking the pressures for the abscissas and the expansions taken for each kilogram of rise in pressure for the ordinates.

RIGHT SIDE.

Pressures.		P		Q		R	
Kil. per sq. cm.	Lbs. per sq. in.	Mm.	In.	Mm.	In.	Mm.	In.
1	14.22	1.25	.050	1.5	.06	0.5	.02
3	42.67	1.50	.060	1.8	.07	0.7	.03
6	85.33	1.90	.080	2.4	.09	0.8	.03
11	156.00	2.50	.100	3.0	. 2	1.0	.04

LEFT SIDE.

Pressures.		P_1		Q_1		R_1	
Kil. per sq. cm.	Lbs. per sq. in.	Mm.	In.	Mm.	In.	Mm.	In.
1	14 22	0.75	.030	1.1	.04	0.35	.01
3	42.67	1.10	.040	1.3	.05	0.45	.02
6	85.33	1.40	.055	1.6	.06	0.60	.02
11	156.00	1.20	..050	2.1	.08	5.70	.02

TABLE III.

Pressures.									Lbs. 14.22	28.44	42.67	56.89	71.08	85.33	99.5	113.8	128	142	156
Time.																			
Front.... Firebox.... ...	.001	.002	.036	.070	.087	.110	.12	.130	.15	.16	.17	.18	.19	.19	.190	.19	.19	19	.19
Front.... Shell..........	....	..	....	.006	.012	.020	.03	.040	.05	.09	.11	.12	.14	.16	.165	.18	.19	.19	.19
Back .... Firebox	.001	.002	.030	.040	.060	.070	.83	.100	.11	.13	.14	.16	.18	.19	.190	.19	.19	.19	.19
Back .... Shell........ ...	...	....	...	.006	.012	.018	.30	.036	.05	.10	.106	.12	.14	.15	.170	.18	.19	.19	.19

Finally, in order to compare the results obtained as easily as possible, the three curves showing respectively the expansion of the fire-box and the different portions of the shell have been brought together in the same figure. Thus the curve λ shows the expansions of the fire-box measured from the top of the rod, which is screwed into the crown bar; the curve μ the expansions of the outer shell measured at its highest point; the curve ν the expansion of the shell measured at the height of the brackets (average of the expansions of the right and left side).

The differences in the ordinate of the curves λ and μ corresponding to the same abscissa represents at each moment of the test the distance which separates the ends of the crown bars from their brackets. The ordinates of the curve λ represent the vertical rise of the crown bars increased by the expansion of the crown bar itself, and the rod which rises from it.

The ordinate of the curve μ represents the vertical rise of the brackets increased by the vertical expansion of the arc $A A_1$.

Now, the bend of this arc is practically equal to the sum of

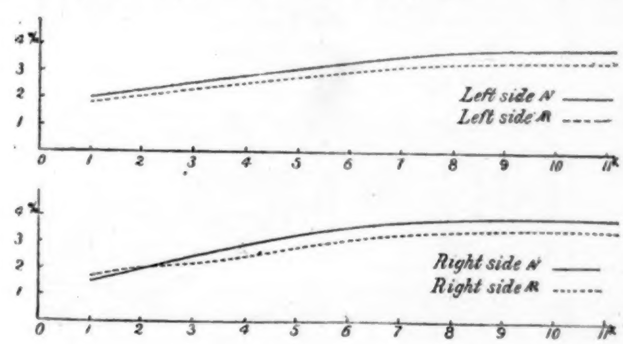


Fig. 4.

the lengths of the crown bar and the rod. As this rod is of the same temperature as the shell, and as, on the other hand, the test showed that the arc $A A_1$ expands regularly, the vertical expansion of this arc is equal to the sum of the expansions of the crown bar itself and the rod.

The ordinates of the curves λ and μ therefore represent respectively the vertical displacement of the ends of the crown bars and the brackets both increased by the same quantity.

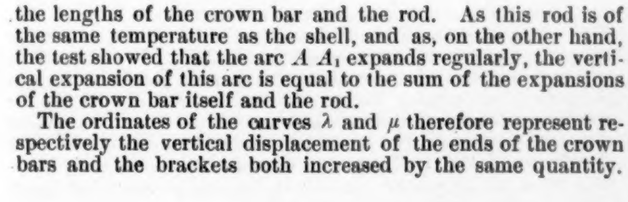
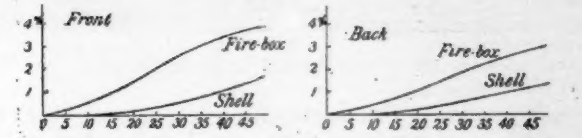


Fig. 5.

Consequently the difference of these ordinates represents the interval which separates the ends of the crown bars from their brackets. This having been demonstrated, it is easy to deduce from an examination of the curves, figs. 6 and 7, the course of the phenomena which occur during the expansion and the generation of a pressure in the boiler. As soon as the fire is started the crown-sheet of the fire-box rises; the crown bars leave their brackets; the interval which separates them increases, and reaches a maximum of from .08 to .1 in. at a pressure a little below 1 kg. per square centimeter (14.22 lbs. per square inch). The pressure of steam upon the fire-box gradually checks this ascensional movement of the bars; starting from the time when the pressure reaches 6 kg. per square centimeter (85.14 lbs. per square inch), the crown bars remain practically stationary; the pressure of the steam is then sufficient to counterbalance the strain of expansion.

At no time does the pressure exerted by the steam produce

Fig. 6.



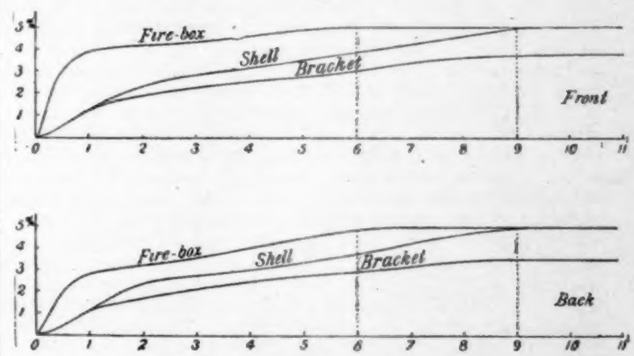


Fig. 7.

any deflection of the crown sheet—that is to say, there is never any negative variation. In the mean time, the brackets following the variations of the temperatures of the mass of water on that of the fire-box rise slowly and gradually. The interval which separates the ends of the crown bars diminishes from the time the pressure reaches 1 kg. per square centimeter (14.22 lbs. per square inch), and at a pressure of 9 kgs. (128 lbs.) the brackets and ends of the crown bars come together, and from this time on the contact established remains fixed. The test was only carried on until a pressure of 11 kgs. (156 lbs.) was reached. The fire was then drawn and the cooling of the boiler watched. The variations of the fire-box and of the outer shell were observed at decreasing pressures. The variations measured were exactly the same as before for the fire-box and shell.

Conclusions.—The conclusions which can be deduced from this experiment for boilers of a type similar to the one examined are as follows:

1. On starting the fire the crown-sheet of the fire-box rises freely. The crown bars do not hinder this movement. They rise with the crown-sheet, and are separated from their supports.

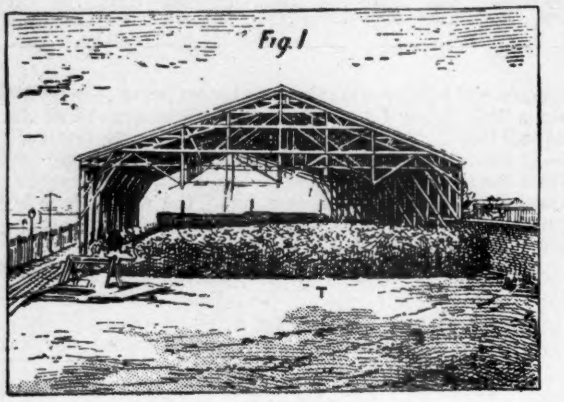
2. The interval which separates the crown bars from their supports reaches a maximum of from .08 to .1 in. when the pressure is about 14.22 lbs. per square inch.

3. Some time before the maximum pressure is reached the crown bars are back again in contact with their supporting brackets.

4. Finally, under the normal conditions of running, the contact remains fixed permanently between the crown bars and their supports.

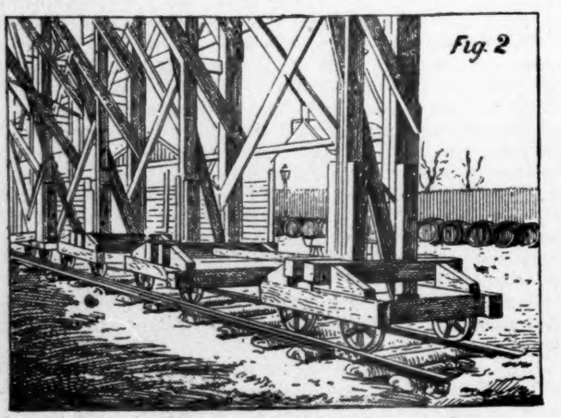
TRANSPORTING BUILDINGS.

The transportation of a hotel in Coney Island, from one site to another, was a remarkable piece of work of its kind. A similar work, but on a less pretentious scale, has been recently executed at Rouen, and as the details of the operation are both interesting and instructive, we extract our information and cuts from our contemporary, *Le Genie Civil*. The building removed consisted of a large shed, constructed of timber



MOVING A LARGE SHED AT ROUEN.

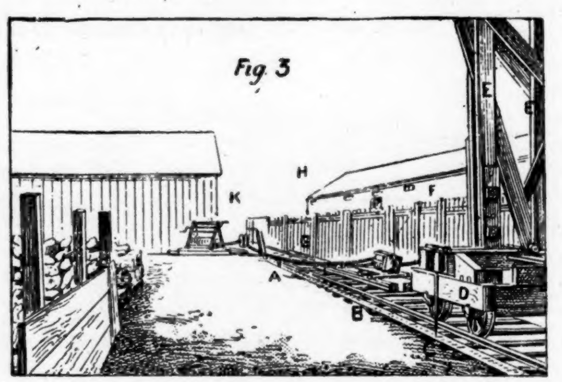
and iron, on the Polonceau system, 164 ft. long by 97 ft. in width, in a single span. There were 12 trusses in all, and consequently 11 bays, each of which had a length of 14 ft. 6 in. The roof principals are supported on double posts, as shown on figs. 1 and 2, measuring transversely over all about 3½ ft., and respectively 13 in. and 9 in. in breadth. They rest upon brick blocks or small pillars, having sheet iron beds, and are 24 ft. in height above the sill. The rafters consist of a trussed girder 2 ft. 7 in. in depth, with upper and lower solid timber chords, united by vertical and diagonal struts and ties, also of wood. Double raking struts are run from the half length and the feet of the side posts to brace the whole framework solidly together. Each rafter carries five purlins 9 in. by 3½ in., which, together with the ridge piece and the pole plate, support the common rafters. In addition to the truss composing the main rafter, the entire roof principal is strengthened by iron in the following manner: A tie-rod, slightly raised at the center, connects the two opposite posts. Two cast-iron vertical struts attached to the central part of the lower chord of the rafter carry a couple of iron tie-rods, one of which is connected with the ridge, and the other with the feet of the rafters. Between the posts, timber bracing in the form of St. Andrew's cross, and horizontal ties are introduced, as shown in fig. 2.



TRUCKS UNDER EACH PRINCIPAL.

Tiles are used for the covering, and the roof has a slope of 20°. Adding the weight of the rolling load, 32 tons, to 148 tons, the weight of the shed, we have a total load of 180 tons to be shifted.

It is obvious that the crucial part of the undertaking was in the displacement of the 24 supporting posts at one and the same time. It was also absolutely indispensable that this lifting operation should be accomplished in a manner which would not in the least degree alter or disarrange the relative positions of the posts. A very slight distortion or deformation at the base of the rectangle formed by the shed would have given rise to very serious consequences. Fortunately for the economical item in the transport, the slope of the ground over which the shed had to be moved was inappreciable, and the posts when in their new position would only require to be raised some 10 in. For these reasons the tractive, lifting, and other mechanical appliances required were not of a very elaborate or expensive character, being composed of a couple of winches, cables, and some strong blocks, which had been previously employed in hoisting some of the flat-bottomed native craft into a workshop in Rouen. Rails, sleepers, wagon axles, screw-jacks, and other necessary plant were procured with facility, and the construction of the special trucks completed the preparations. Before commencing the work, the first step consisted in laying down a rail track underneath each line of posts, as shown in fig. 2, and then building round each double pillar a truck mounted upon two axles, with wheels 2 ft. in diameter. These axles are 4 ft. 3 in. apart, and are united by longitudinal side and end pieces of oak bolted together and forming the frame of the truck, figs. 2 and 3. Upon the side pieces are placed two cross sleepers of pine, which carry the vertical flitches bolted lengthways to the posts. The cross sleepers are maintained in their place on the frame of the truck by four chocks bolted on. In order to lift a post on to its special truck, it was necessary to raise the sleepers by screw-jacks about 3½ in., and since they are bolted to the post, the latter cleared its brick pillar, and was kept in place by suitable wedges driven in between the bottom of the sleepers and the side frame of the truck. As a precaution against the occurrence of any deformation of a magnitude likely to be



CONNECTION OF TRUCKS AND HAULING TACKLE.

dangerous, a pair of posts in the same range were lifted at a time, the whole 3½ in. being divided between a couple of lifts. As soon as all the trucks had received their loads they were coupled together by wrought-iron rods 1¼ in. in diameter to transmit the traction in the line of the posts, and also for the purpose of preserving the exact distance between them. It was necessary to arrange the lift in such a manner that when the cross sleepers had to be lowered they should not touch the side frame of the truck before the posts had taken their bearings upon the new piers, as it was impossible at that stage of the operations to dismount the axles.

At the far end of the distance to be traversed, about 200 ft., and in alignment with the axis of each of the two lines of posts, was fixed the hauling arrangement, which was thus installed. A couple of oak piles, 20 ft. long and 14 in. in diameter, were driven into the ground by a small pile-driver, one at a distance of 30 ft. from the middle of the last principal when in its new position, and about 1 ft. out of the line of the longitudinal axis of the posts. The other was driven at a distance of only 22 ft. from the same point, as a small building prevented it being placed further off. These piles constitute the *points d'appui* for the whole of the haulage; and to each of them was attached a block with three pulleys, 1 ft. in diameter, while another block was fixed to a stirrup which was fastened to the two cross sleepers of the leading truck. At each side of the two large mooring piles already described another pile was driven, 10 ft. in length and 9 in. in diameter, which served as a fixed point for the haulage cable, which, starting from here, passes successively round the two blocks, forming a pulley with six sheaves. It then winds on a winch placed inside the building at a distance of 12 ft. from the line of axis of the posts, and 4 ft. from the line of the middle of the last principal when in its new position.

The cable has a diameter of 2 in., and the winch a drum 1 ft. 8 in. in diameter. In front of this winch, on the same frame, a second drum is fixed capable of turning freely on its axis, the object of which is to prevent the lateral displacement of the cable during the haulage. A reference to fig. 3 will explain the position of the different pieces of mechanism employed in effecting the transportation of the shed. *A B C* is the graduated plank laid down along the whole length of the route to insure uniformity of progression in all the separate trucks. At *C* the pointer is shown which is attached to the leading truck on each side, and, by the conditions laid down, the distance or the number of graduations passed over at any time is a known quantity. The trucks and the roof posts are *D* and *E*, while *F* is the pulley block through which the hauling ropes pass to the winch. The fixed point already mentioned is the pile driven at *H*. In the event of the progression not being uniform for both lines of haulage, the men working the winches were signalled to slacken or accelerate the motion so as to preserve the necessary parallelism between the two lines of traction. This system answered exceedingly well, as the greatest discrepancy did not exceed a ½ in., while the smoothness of the movement did not permit of a single flaw making its appearance in the structure, or of a glass breaking.

A useful comparison may be drawn here between the conditions attending the haulage of the trucks carrying the shed and a goods train composed of the same number of wagons. Each wagon of the train, although connected with its two neighbors in front and rear does not constitute a component part of a rigid frame, which would be destroyed if any distortion or deformation took place. On the contrary, the couplings allow a certain amount of "play." In starting, therefore, a train of a dozen wagons, supposed of uniform weight, the locomotive has to overcome only one-twelfth of the total inertia of the whole load, as the wagons get off successively and not simultaneously. But with the 12 trucks in each train carrying the posts of the shed it was essential to make the attachments of a solid character by means of bracing, so as to keep their relative distances unaltered, and also before starting the total inertia of the mass to be transported had to be overcome. The conclusion to be drawn from the undertaking we have described is, that in the horizontal displacement of large rigid masses, carried on trucks on rails, we may take, without laying down any hard-and-fast line, the coefficient of traction at 0.07 of the weight of the load to be transported.—*The Engineer*.

THE USE OF GAS MOTORS IN GERMANY.

Mr. Frank H. Mason, Consul General of the United States to Germany, has made a report on the Use of Gas Motors in Germany, from which we make the following extract:

"Prominent among the economies which have been introduced during recent years in Germany is the use of gas motors in place of steam-engines in all the smaller forms of manufacture where the motive force required does not exceed 75 to 100 H.P. At the Frankfort Electrical Exposition of 1891 most of the dynamos were driven by gas and caloric engines, and the display of these motors at that time was almost as varied and interesting to the general public as that of the electrical apparatus to which they were technically subsidiary.

There were in operation at that time throughout Germany about 16,000 gas motors, with an aggregate motive force of 60,000 H P. Since then the gradual cheapening of gas and the rapid extension of electrical lighting and electrolysis have combined to increase very rapidly the use of gas motors, the effectiveness and economy of which were so brilliantly demonstrated at the Frankfort Exposition. No statistics are available to show the precise number that are at present in use; but, as the two principal makers of gas-engines in Germany have alone made and delivered during the past two years 1,950 motors, it may fairly be inferred that the number in actual service in this country is not far short of 24,000 or 25,000.

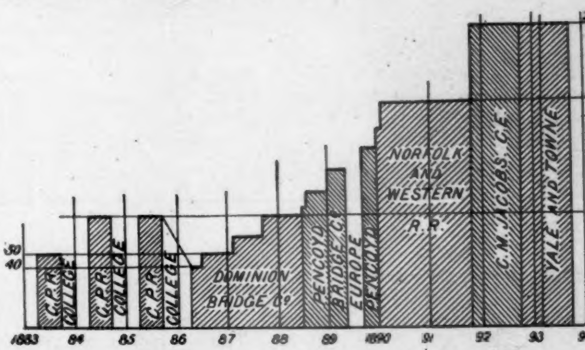
Meanwhile the progress that has been made in improving the machines and increasing their economy has been quite remarkable. The first gas motors, which were exhibited and used experimentally about 1868, were fatally extravagant. The Lenoir machine, which was the best model known to Germany as late as 1861, used—according to a recent statement in *Kuhlow's Trade Review*—1,235 cub. ft. of gas per H.P. per hour, whereas the motors now in use consume only 28 ft. per H.P. per hour in small machines, and in large sizes as low as 23.75 ft.; so that 21.2 cub. ft. of gas per hour will run an incandescent lamp of 16 candle power, and this proportion is said to have been reduced in large plants which employ motors of 500 H.P. and more to 17.6 cub. ft. of gas per H.P. per hour.

How economical such a motive power must be for all the smaller forms of manufacture, and especially for electrical lighting by isolated plants, will be apparent from the following tabular statement of the price per 1,000 cub. ft. of gas which prevails at present in the principal cities of Germany:

Altona, Bremen, and Mayence	$1 36
Brefeld (with discount to large consumers)	1 32
Brunswick, Bonn, and Strasburg (without discount)	1 21
Magdeburg, Leipsic, and Breslau (with discount)	1 21
Barmen (with discount)	1 19
Dantzig and Dresden	1 14
Berlin and Königsberg (without discount)	1 09
Cassel, Dortmund, Elberfeld, and Hanover (with discount)	1 09
Frankfort (with discount)	1 07
Stettin, Essen, and Cologne	1 02
Bochum	95

AN ENGINEER'S CAREER REPRESENTED GRAPHICALLY.

A short time ago a young engineer called at the office of The American Engineer seeking employment. Among the documents which he submitted as evidences of his past experience was a blue print, from which the diagram herewith has been engraved. In this the horizontal distances represent time, and the base-line is divided into spaces which represent years, as indicated by the figures below it. The vertical distances represent his salary, as indicated by the horizontal lines, and the figures at the ends of them indicate the amounts received per month. The diagram shows that he began his career on the Canadian Pacific Railway at $50 per month. In alternating periods he was in college, and with the Canadian Pacific Road later at $75 per month. In 1886 he went to the Dominion Bridge Company, when the slip-like diagram shows successive increases in salary. The same is true of his connection with the Pencoyd Company. Afterward he went with the Norfolk & Western Road, and received $150 when he left. Still later he was employed by C. M. Jacobs, and afterward by Yale & Towne at $200 per month.



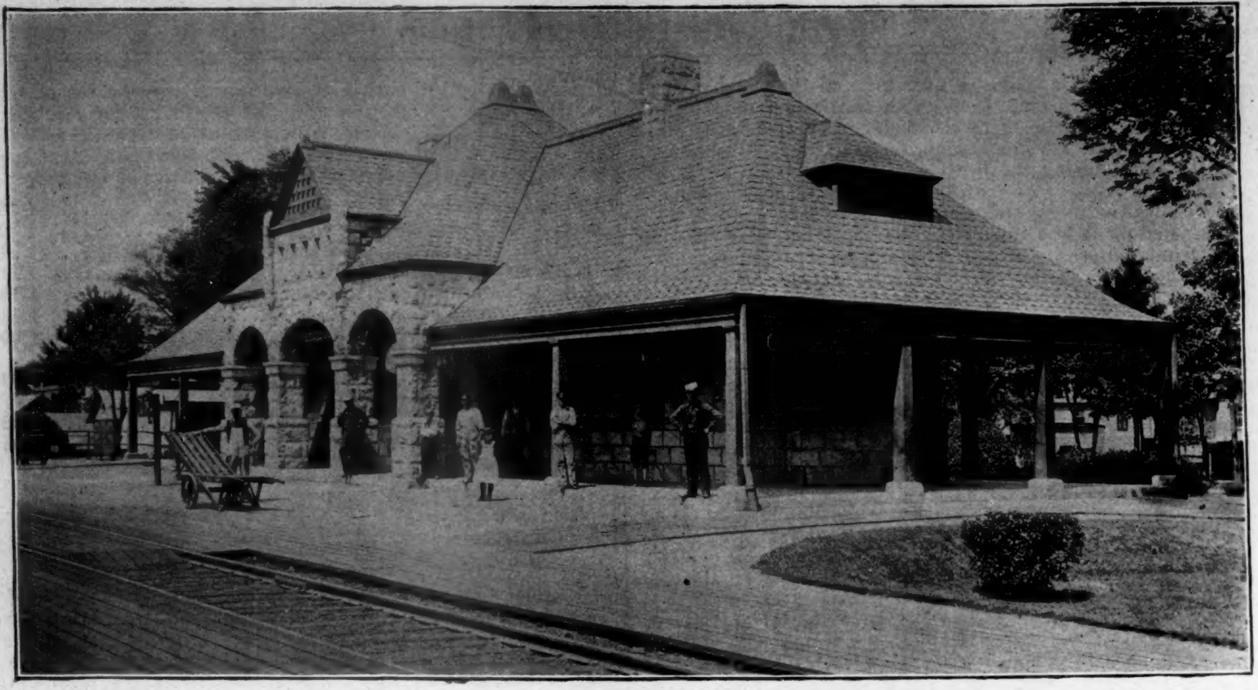
GRAPHICAL REPRESENTATION OF AN ENGINEER'S CAREER.

Such a diagram is an excellent one for people out of employment to have. It shows at a glance what they have done and what they have been paid, and is a graphical history of their past careers and experience.

As intimated at the beginning of this notice, the author of this diagram is out of employment and wants a "job." It is safe to say that any one able to do as creditable and ingenious a piece of work as the diagram shown by our engraving has the ability of making himself very useful wherever he may be employed. His name and address may be obtained by addressing the Editor of The American Engineer.

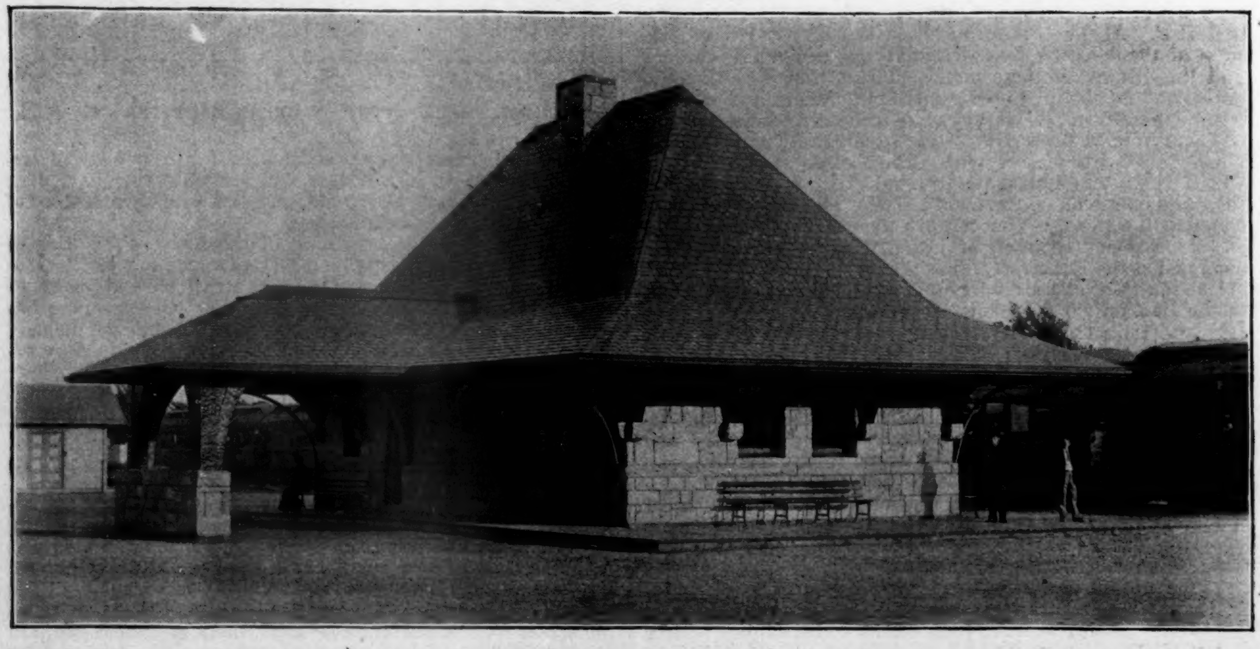
THE LUHRIG COAL WASHING PLANT.

At the September meeting of the British Iron and Steel Institute, James l'Anson, of Darlington, read a paper describing the Luhrig coal washing and dry separation plant, which was then in process of construction at a pit of the North Bitchburn Coal Company, Evenwood. This plant is to handle 1,000 tons of coal per day as drawn from the pit. It has two drawing shafts from which the coal as it comes to bank is run into tipplers of improved construction, whence it is delivered by means of short traveling bands on to the shaking screens, of



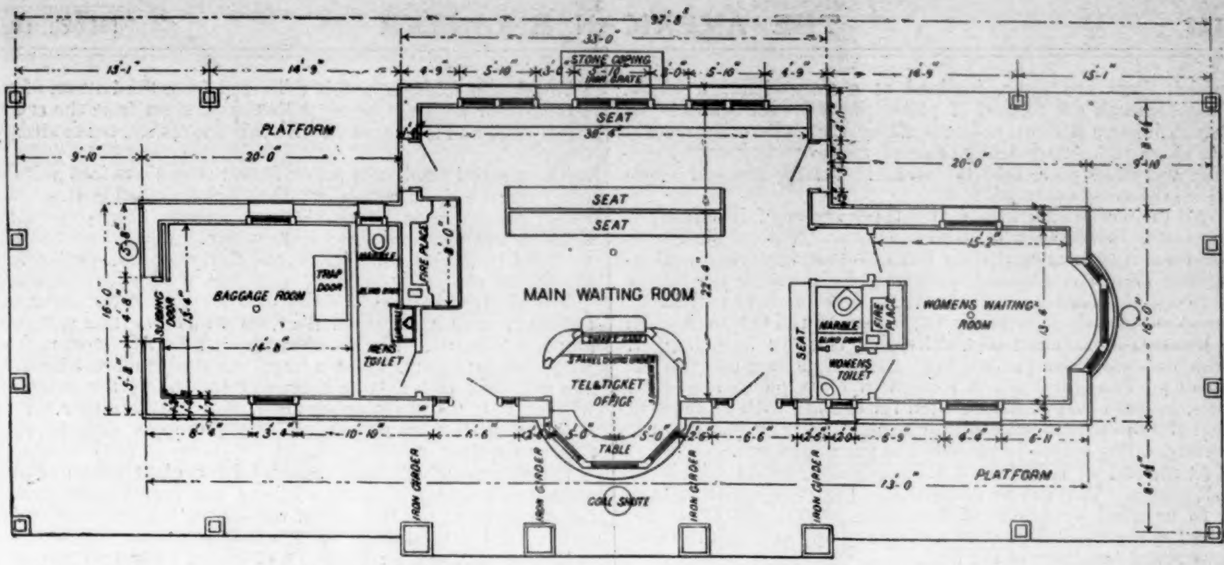
Station at Westfield, N. J.

Station at Interlaken, N. J.

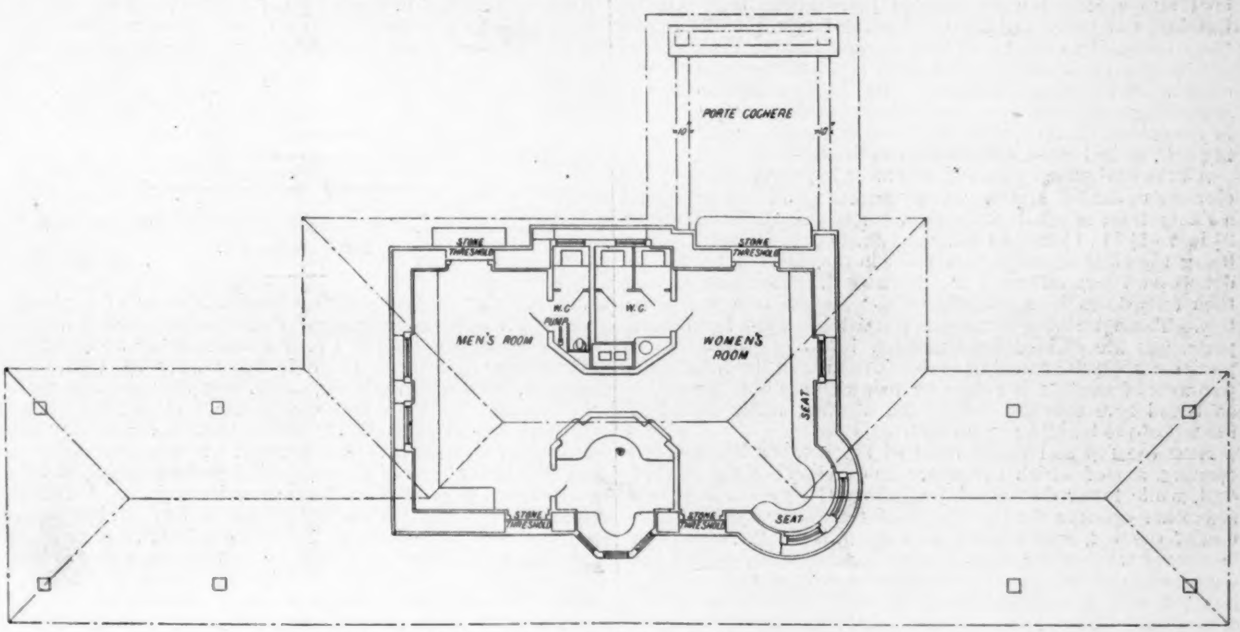


Station at Little Silver, N. J.

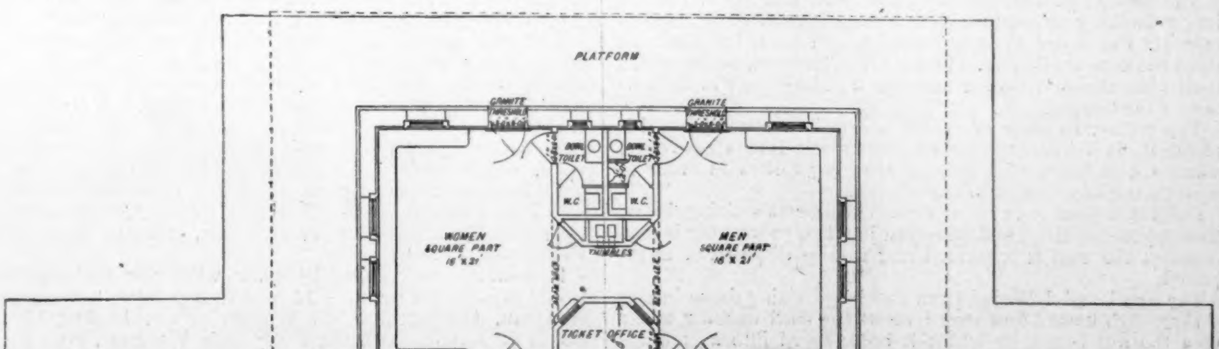
SUBURBAN STATIONS ON THE LINE OF THE CENTRAL R. R. OF NEW JERSEY. PHOTOGRAPHED BY PACH BROTHERS, NEW YORK.



GROUND FLOOR PLAN OF STATION AT WESTFIELD, N. J.



GROUND FLOOR PLAN OF STATION AT INTERLAKEN, N. J



GROUND FLOOR PLAN OF STATION AT LITTLE SILVER, N. J.

SUBURBAN STATIONS ON THE CENTRAL RAILROAD OF NEW JERSEY.

which there are three, inclined at a somewhat low angle. These screens are formed of plates pierced with round holes, which insures a more uniform sizing than where bar screens are employed. Any desired size of mesh can be used by putting a suitable plate into the screen. Usually holes of about $2\frac{1}{4}$ in. diameter are employed.

All the coal which passes over these screens falls on traveling belts, upon which it is hand picked. Two of these belts are formed of bars carried by links, so that any small coal resulting from the cleaning process falls through the spaces between the bars on to flat sheets, whence it is carried by scrapers, placed transversely to the line of the belt back on to a transverse traveling belt, delivering it into a large hopper, which also receives the whole of the coal passing through the screens. The third belt is formed of close plates instead of bars, in order that it may be used for dealing with unscreened coal if required, in which case a blind plate is put into the corresponding screen in place of the perforated one.

At the end of each belt is a loading arm, round which the belt passes. This can be lowered into the empty truck which is to be filled by means of hydraulic power, and gradually raised as the truck fills, thus saving any appreciable drop and consequent breakage of the coal.

The coal passing through the screens falls on to a traveling belt formed of plates in the trough form, by which it is delivered into a large hopper situated just outside the washery building and below rail level. A second belt, parallel to the first, delivers into trucks, so that the coal passing through the screens can be automatically loaded at once, should it be desired to send it away unwashed. Provision is also made for separating nuts of any required size, by putting a second plate in the screen, which can be delivered on to the second traveling belt, to be loaded unwashed if desired.

All the coal which goes into the large hopper is taken by an elevator to the top of the washery building and delivered into a sizing drum or revolving screen, where it is sorted into nuts $2\frac{1}{4}$ in. to $1\frac{1}{2}$ in., $1\frac{1}{2}$ in. to 1 in., and 1 in. to $\frac{3}{8}$ in. diameter (these being the sizes of the round holes in the shells of the sizing drum), and small from $\frac{3}{8}$ in. downward. Each size of nut then falls down its appropriate shoot into its own washing-box. These washing-boxes are formed of wood lined with plate, and are divided longitudinally into two sections by a partition not quite reaching to the bottom. In the front compartment of the box is a sieve on to which the nuts are delivered, and here they are met by the washing water, forced to the top of the building by a centrifugal pump.

Near the top and to the front of the box is a longitudinal opening, out of which the water flows, carrying the washed coal, while lower down and just above the level of the sieve is another opening for the escape of the refuse. At the bottom of the box, which is hopper shaped, is a valve which can be opened when required to let out any fine refuse which has passed through the sieve. The back compartment of the box is fitted with a wooden piston, actuated by an eccentric of appropriate throw, upon a line of shafting, the stroke of the piston being proportioned to the size of the material under treatment.

The washed coal passes from the front and top of the box into a draining shoot, to which a vibrating action is given to separate the water more effectually, and from the draining shoot the nuts are delivered into loading hoppers, under which trucks are run and loaded through a sliding door in the bottom of the hopper.

The refuse, to some of which a certain amount of coal is adherent, is delivered from its proper exit into a conveyer, whence it is taken to a pair of crushing rollers in order to separate the adherent or intergrown coal.

From this point it is taken by an elevator to a sizing drum, graded into two sizes, and delivered into two re-washing boxes, in which the coal is recovered and can be disposed of as required.

The small coal delivered from the large sizing drum in size of three-eighths and downward, meets the used washing water from the nut boxes, by which it is conveyed into a grading-box situated behind the small coal washing-boxes.

Each section of the grading-box delivers its own size of coal into a washing-box similar in construction to the nut washing-boxes, but having a layer of feldspar crystals resting upon the sieve. The necessary impulse is given to water by pistons similar to those already described, but of shorter stroke, proportioned to the fineness of the coal to be treated. This bed of feldspar is an important factor in the washing of fine coal, opening and closing with the impulse of the water, and permitting the heavier dirt to pass through while the coal is suspended above.

The washed fine coal passes out of the front of the boxes, as already described in the case of the nuts. The dirt passes through the feldspar and is delivered from the bottom of the boxes, after which it mixes with the product from the crushing rollers, and is re-washed with it in the special boxes already described.

The washed small coal passes from the washers into a draining drum of $\frac{1}{32}$ in. mesh, all the coal above this size being subsequently taken by an elevator into storage hoppers for delivery to the coke ovens or elsewhere. The effluent water, with all the finest coal below one thirty-second, passes into the sludge recovery.

The sludge recovery consists of a long chamber under the building, with a cemented floor, on which the fine sludge is allowed to settle. In this chamber is a slowly moving belt with cross scrapers, which scrape the sludge off the bottom, and deliver it into a large hopper at the end of the chamber, whence it is taken by an elevator, and can be either mixed with the small coal in the same storage hopper or kept separate, as required.

The degree of efficiency secured by a plant such as is described above may be gauged by the guarantees given by the Luhrig Company in the case of the one erected at Motherwell, and which has been fully borne out in practice. These guarantees are as follows: Capacity of plant, 1,500 tons per day of 10 hours, on the basis of the coal containing 23 per cent. of ash. Ash contained in washed coal of five-sixteenths to one-thirty-second not to exceed 6 per cent. The rubbish or dirt which has been washed out is guaranteed not to contain more than 2 per cent. of fine coal. The cost of labor is guaranteed not to exceed eight-tenths of a penny per ton of coal handled, including labor in hand picking, sorting, washing, and loading into trucks. In practice, it is found that the ash does not exceed $2\frac{1}{2}$ per cent., the coal in the dirt 1 per cent., and the labor $\frac{1}{2}d.$ per ton.—*American Gaslight Journal.*

RAILROADING UNDER THE REIGN OF GEORGE IV.

On another page we give a fac-simile copy of a placard, which gives "An Abstract of Penalties Imposed by the Act of Parliament of George IV., for making the Stockton and Darlington Railway," which is dated July 10, 1827. The original, from which this was made, was among the papers of the late Horatio Allen, and was probably obtained by him at the time he was in England, and contracted for the first locomotives ever brought to this country. It was reduced to just half the linear scale of the original in order to admit of being printed on a page of The American Engineer. It requires either good eyesight or strong glasses to be read, but will repay the close attention required to decipher it. Some of the rules are very quaint, and have an ancient flavor that is interesting. For example, Rule 6, "Every person neglecting to shut Gates made across the Railway through which he shall pass, shall forfeit a Sum not exceeding £2." Probably Rule 7 might be adopted in many places in this country to the advantage of shippers. It reads: "Every Wharfinger giving a Preference to any Person in the loading or unloading of any Waggon or Waggons shall forfeit a Sum not exceeding £2."

The fifth penalty imposed by the railway company speaks of the gauge of the wheels being "4 *ft.* $5\frac{1}{2}$ *in. from* the outside of the flange of each wheel." From this it may be inferred that the original gauge of the Stockton & Darlington Railroad was less than 4 ft. $8\frac{1}{2}$ in. Tradition tells us that the rails were originally 5 ft. over their outsides and were 2 in. wide, which would leave the gauge 4 ft. 8 in., and that in order to ease the vehicles on curves the rails were spread an additional $\frac{1}{2}$ in. Even if this were the case, the wheels must have had $1\frac{1}{2}$ in. end play on each side, or $2\frac{1}{2}$ in. altogether, which now seems excessive.

It would be interesting to know what our trades-unions would say about a rule like 14, which stipulates, "Every Engine-man, Carriage-man, or Waggon-driver, loading Coals, Goods or Materials, on the Company's Waggons, who shall suffer the Axles of such Waggons at their '*bearances*' or journals to be without Oil or Grease, shall forfeit a Sum not exceeding £1."

Regulation 25 is also curious. It stipulates that "Every Person who shall refuse to take the Passing or Siding Place, in the approach of a Locomotive Engine, shall forfeit a Sum not exceeding 10s." The rules which follow and which govern the right of the road also sound curiously in these days of train dispatching and block signals. Rule 28, for example, has an antediluvian flavor. It reads, "Locomotive Engines shall be exempt from taking the Sidings, except in meeting another Locomotive Engine; in that case the Empty Train shall take the Siding."

Stockton & Darlington RAILWAY.

AN ABSTRACT OF PENALTIES,

Imposed by the Act of Parliament of Geo. IV. for Making the said Railway.

	£.	s.	d.
1. ANY Person neglecting or refusing, to give the Collector of the Rates or Tolls, an Account in Writing of the Quantity of Goods or other Things, in any Waggon or other Carriage, from whence brought, and where intended to be unloaded or [illegible], or refusing to produce a Bill of Lading, or giving a false Account, or shall deliver any part of his Lading at any other Place than what is mentioned in such Account, shall forfeit for every Ton so delivered	0	10	0
2. ANY Person Riding, Leading, or Driving, any Horse, Mule, Ass, Cow, or any other Cattle, upon the said Railway, or any Part thereof, shall forfeit a Sum not exceeding	2	0	0
3. ANY Person [illegible] upon the said Railway, with any Waggon or other Carriage not properly constructed, except in crossing the same, by the Occupier of adjoining Grounds, and in passing any Public or Private Roads, shall forfeit a Sum not exceeding	5	0	0
4. EVERY Owner of Waggons neglecting to enter his Name and Place of Abode, and the Number of his Waggons or other Carriages, with the Clerk of the Company, and neglecting to Paint such Name and Number, in white Letters and Figures, on a black Ground, three inches high at least; and for refusing to permit such Waggons or Carriages to be gauged or measured at the Expense of the Company, shall forfeit a Sum not exceeding	5	0	0
5. FOR Damage, Spoil, or Mischief, done to the said Railway, and the Works thereof, or to adjoining Lands, by any Waggon or other Carriage, or the Waggoner or other Person belonging thereto, if such Damage [illegible], the Owner thereof shall pay the Amount of such Damage, Spoil, or Mischief, and shall also forfeit a Sum not exceeding	2	0	0
6. EVERY Person neglecting to shut Gates made across the Railway through which he shall pass, shall forfeit a Sum not exceeding	2	0	0
7. EVERY Wharfinger giving a Preference to any Person in the loading or unloading of any Waggon or Waggons, shall forfeit a Sum not exceeding	2	0	0
8. ANY Person suffering any Carriage to remain on the Railway, and obstructing the Passage thereof, and shall refuse to remove such Carriage when required so to do, shall forfeit a Sum not exceeding	0	5	0
9. ANY Person breaking, throwing down, or destroying, stealing, or taking away, any Part of the said Railway, or any of the Works thereof, is subject to the like Pains and Penalties as in case of Felony.			
10. EVERY Collector of Tolls who shall demand or take a greater Rate of Tolls than fixed by the Company, shall forfeit a Sum not exceeding	5	0	0

PENALTIES,

IMPOSED BY THE BYE-LAWS OF THE RAILWAY COMPANY,

Made on the 10th Day of July, 1827.

	£.	s.	d.
1. EVERY Driver absenting himself from his Horse, Carriage, or Steam Engine, [illegible] during the same, shall forfeit a Sum not exceeding	0	10	0
2. EVERY Driver refusing to declare his Christian and Surname, and Place of Abode, or the Name of [illegible], when required by any Proprietor, or any Agent or Servant of the Company, shall forfeit a Sum not exceeding	2	0	0
3. ANY Person drawing off any Waggon, except at the proper [illegible], shall forfeit [illegible]	5	0	0
4. EVERY Person passing upon the Railway with a Waggon or Waggons earlier than one Hour before [illegible] or later than one Hour after Sunset, without leave in writing, from the Company, or their [illegible], shall forfeit a Sum not exceeding	2	0	0
5. EVERY Driver or Owner of any Waggon, the gauge of the Wheels of which not being [illegible] from the Outside of the Flange of each Wheel; nor having the Tread of any Wheels less than 3 Inches, or the Axles more than 4 Feet apart from Centre to Centre, shall forfeit a Sum not exceeding	0	5	0
6. EVERY Driver or Owner of any Waggon, not having with such Waggon a proper Break to regulate [illegible], shall forfeit a Sum not exceeding	2	0	0
7. EVERY Driver suffering any Coal, Stone, or other Materials, which shall fall off any Waggon [illegible] which he shall Team from any such Waggon, or suffer the same to proceed from or come out of such Waggon, to remain on the said Railway, and obstruct the Passage thereof, shall forfeit [illegible]	2	0	0
8. EVERY Driver of a Waggon or Waggons, who shall not give immediate notice to one of the Company's [illegible] of any Waggon passing on the Railway, having broken or displaced any Rail, shall forfeit a Sum not exceeding	2	0	0
9. EVERY Person who shall refuse to deposit any Goods or Merchandize, which shall be discharged from [illegible] Waggon, or other Carriage, on any of the Company's Wharfs, in the place directed by the Wharfinger, or Superintendent, of the Company, shall forfeit and pay any damage or injury occasioned by such refusal, and shall also forfeit a Sum not exceeding	2	0	0
10. EVERY Owner of Coals, Lime, Minerals, Lead, Goods, or Merchandize, who shall suffer the same to remain [illegible] on the Railway, in the Waggons carrying or conveying the same to the inconvenience of Traders thereon, shall forfeit and pay to the Company the expense of removing such Goods or Merchandize, and also a Sum not exceeding	2	0	0
11. ANY Agent, or Toll Collector, being himself the owner of, or interested in any Waggons or Horses, or any Coach or Coaches for the conveyance of Passengers, trading or passing on the Railway, being a dealer in, or retailer of Liquors, Victuals, or any other Goods upon the Railway, without leave of the Committee or Sub-Committee, shall forfeit a Sum not exceeding	5	0	0
12. EVERY Engine-man, who shall permit any Person or Persons, except his Assistants, or the Company's Agents or Servants, to ride upon any Locomotive Engine, or any Waggon or Carriage connected therewith, shall forfeit a Sum not exceeding	0	10	0
13. EVERY Engine-man, Carriage-man, or Waggon-driver, who shall leave the Coupling Bars or connecting Chains of Waggons on any part of the Railway, except the Place or Places appointed by the Company's Engineer for leaving the same, shall forfeit a Sum not exceeding	0	10	0
14. EVERY Engine-man, Carriage-man, or Waggon-driver, leading Coals, Goods, or Materials, in the Company's Waggons, who shall suffer the Axles of such Waggons at their bearances or journals to be without Oil or Grease, shall forfeit a Sum not exceeding	1	0	0
15. EVERY Person, except the Company's Agents or Servants, who shall ride upon any Waggon or Engine, passing on the Railway, without having obtained the Licence of the Company or their Agents, shall forfeit a Sum not exceeding	0	10	0
16. EVERY Engine-man, Waggon-driver, or Coach-driver, who shall neglect to give Notice to the Company, or their Agents, of any Accident happening to any Waggon or other Carriage on the Railway, shall forfeit a Sum not exceeding	0	10	0
17. EVERY Engine-man, Waggon-driver, or Coach-driver, who shall neglect to adjust the Switches to answer the Road he shall be going, shall forfeit a Sum not exceeding	1	0	0
18. EVERY Engine-man, Waggon-driver, or Coach-driver, who shall take a Siding, and shall neglect to adjust the Switches to answer Carriages passing down the Main Line, shall forfeit a Sum not exceeding	1	0	0
19. EVERY Person who shall lay or deposit Stones, Coal, Lime, Timber, or any other Material on the Railway or Foot-paths, shall forfeit a Sum not exceeding	1	0	0
20. EVERY Owner or Driver of any Coach or other Carriage, used on the Railway, for the conveyance of Passengers, who shall refuse to conform to, or shall disobey any of the Rules, Orders, and Regulations of the Company, or their Committee or Sub-committee, relative to the Departure of any Coach or other Carriage from Darlington, Stockton, or any other Place upon the Line of the Railway, or the Standing-Place of any other Coach or Carriage, shall forfeit a sum not exceeding	2	0	0
21. EVERY Owner or Driver of any Coach or other Carriage, used on the Railway, for the Conveyance of Passengers, who shall carry, save for Passengers only, any Parcel or Package exceeding [illegible] weight, shall forfeit and pay a sum not exceeding	2	0	0
22. THE Captain or Captains, Owner or Owners, of part or of the whole of any Vessel or Vessels, laying to the Staiths, for the Shipping of Coal, Lime, and other things, at Stockton, belonging to the Company, for the purpose of taking in Coals, Lime, or other Materials, or any Material or other thing whatsoever, shall causing any Damage or Injury whatsoever to the Staiths, or other erections of the Company, shall be liable to Pay to the Company the damages and expenses occasioned by such Damages or Injury, and shall forfeit and pay any sum not exceeding	2	0	0
23. EVERY Agent or Servant of the Company, who shall neglect to give immediate Notice to the Sub-committee, or one of the Clerks of the Company, of the infraction of any of the above Rules or Bye-Laws, such infraction having come to his knowledge, shall forfeit a Sum not exceeding	0	10	0

Regulations for taking the Sidings.

	£.	s.	d.
24. EVERY Person who shall travel upon the Railway with an empty Waggon or Waggons, and shall refuse to take the Passing or Siding Place, on the approach of a Loaded Waggon or Waggons, shall forfeit a Sum not exceeding	0	10	0
25. EVERY Person who shall refuse to take the Passing or Siding Place, on the approach of a Locomotive Engine, shall forfeit a Sum not exceeding	0	10	0
26. A LOADED Train of Waggons descending, meeting a Loaded Train ascending, the Loaded Train descending shall take the Siding, except when the several Waggons shall meet between Sidings, in that case the Loaded Waggons ascending shall be put back into the next Siding down the Way.			
27. ALL Empty Waggons ascending or descending shall take the Sidings nearest, on meeting Loaded Waggons.			
28. LOCOMOTIVE Engines shall be exempt from taking the Sidings, except in meeting another Locomotive Engine, in that case the Empty Train shall take the Siding.			
29. A COACH, for Conveyance of Passengers, shall not take a Siding unless it shall meet a Locomotive Engine, or Loaded Train of Waggons.			
30. ALL Locomotive Engines, Waggons, and other Carriages passing along the Railway and drawing or carrying Coal, Stone, Lime, Lead, Merchandize, or other heavy Goods, shall on being overtaken by a Coach or Coaches for carrying passengers, stop at the first siding such Locomotive Engines, Waggons, and other Carriages shall arrive at, and allow such Coach or Coaches to pass, and on approaching to meet any such Coach or Coaches, all such Locomotive Engines, Waggons, and other Carriages as aforesaid, shall in all cases stop at the Siding next to the last Siding which such Coach or Coaches may be at, or shall have passed, so as to allow such Coach or Coaches to proceed.			
31. FOR every Infringement of any of the above Regulations, respecting the taking of Sidings, a Penalty shall be incurred by every Engine-man, Carriage-man, Waggon-driver, or Coach-driver, so infringing on any of the above Regulations, not exceeding	0	10	0

The old paper was worn away at the folds and had to be mounted on muslin to be preserved, and is an interesting link between the past and the present.

SUBURBAN STATIONS ON THE CENTRAL RAILROAD OF NEW JERSEY.

DURING the past few years the Central Railroad of New Jersey have been building a large number of model suburban stations, which are not only tasteful in design and of attractive appearance, but are exceptionally well arranged for accommodations of the class of traffic for which they are intended to cater. It will be remembered that in our issue for June, 1893, we illustrated a club car, which was built by the Harlan & Hollingsworth Company for this road, and which, we believe, has recently been put in service for club purposes. There are a number of these cars running from Plainfield and other points into New York on regular trains each day, and the growing suburban population, which ask for special cars, also demands something better for station accommodations than the sheds, which have been too common on the roads running out of New York and doing a commuter traffic. Of the stations which have recently been built we have selected three as being typical of the various designs presented.

The first one is that at Westfield, which is on the main line of the road; the other two are on the Long Branch Division, one at Interlaken and the other at Little Silver. The Westfield Station accommodates a larger traffic, and it will be seen from the photo-engraving published that it has a tastefully designed exterior. It is built of New Jersey light sandstone. The plan of the building, which is given on the page opposite that to the photo-engraving, shows the interior arrangement of the building: the baggage-room at one end, with a main waiting-room central, having fire-places and settees, and into which opens the telegraph and ticket-office, with a bay-window on the track side. At the end opposite to the baggage-room, and forming an end symmetrical with it, with a bay-window added, is the women's waiting-room, supplied with a handsome fireplace and ordinary accommodations. This station was designed by Messrs. Peabody & Stearns, of Boston. It is unnecessary to enter into details of the construction of the foundations and mason work, except to say that the best quality New Jersey sandstone from the Stockton quarries was used for the main walls of the building, Indiana trimming being used. All of the carving on the building is in relief work. The floor joists are supported by hard brick piers, and the chimney and fireplaces and arches are of the same material. The flues for the chimneys are lined with terra cotta lining, and the floor, fireplaces, and hearth with Pompeiian brick laid in colored mortar. The floors are laid with 1-in. thickness of hemlock flooring put on diagonally, over which a facing of Florida comb, clear-tongued and grooved, is laid. The columns supporting the roofs are of Florida heart pine. Pine is used for the doors and window-sashes, and the glass coloring of the windows is of the *ondoyant* colors, carefully selected by the architect. All the interior finishing lumber is of clear seasoned North Carolina pine, hand-planed and sand-papered with the grain, so that it could be handsomely finished in the natural state. The seats are of five-ply perforated back, with bent wood arms and nickel trimmings. The frames are of North Carolina pine. It may be interesting to note the specifications which were laid down for finishing the inside woodwork. All portions of it, except the floor, were given one coat of Rosenberg's filler and two coats of Rosenberg's elastic finish, rubbed down with hair and jute, all putty being put in so as to match the woodwork finish, while the floors were filled and given a wax finish. The building is wired for electric lights with heavy insulated wires, and the ceiling lights are lighted with through switches from the ticket-office.

The other stations—namely, Interlaken and Little Silver—are on the Long Branch Division of the road and are smaller, inasmuch as the traffic to be served at those places is very much less. The general outside appearance is clearly shown by the engraving. They are of stone, with broad covered platforms extending out on either side. The internal arrangements of Little Silver Station are shown on the engraving. There are two waiting-rooms, with a passage-way between, into which the windows from the ticket-office open. The seats run around along one side, which is the end of the building, up to the doors on either side in both rooms. There is nothing particularly novel in the internal arrangement, and the outside is the most interesting portion of the building.

The internal arrangements of the Interlaken Station is practically the same. Here as well as at the Little Silver Station, there is a *porte-cochère* on the side of the building farthest from the track, with a bay-window on the track side. It is only in slight modifications that any differences exist between the two. The general finish and construction of the two buildings are identically the same. The stones used in the construction of the main walls have split faces on the outside, and were laid up in lime and cement mortar. All of the outside finish, such as the windows and doors, and of the timber work, such as the beads, rafters, brackets, etc., are of the best hard pine, rough hewn and pinned together. The finish on the interior is the best hard pine throughout, the sheathing being of $2\frac{1}{4}$ in. strips matched and beaded. This sheathing is vertical for a height of 4 ft. above the floor, and above that it is horizontal. The joint is vertical and horizontal, the sheathing being covered with a 4-in. simple molded cap. The outside and inside woodwork being of hard pine, was given one coat of oil and two coats of hard-oil finish, the first coat being put on as soon as the finish was up. All outside and inside pine and metal work was given three coats of hard lead and oil. It will thus be seen that, while the finish and the details of these buildings do not call for any very great expense in construction, that they are exceedingly tasteful and conveniently designed, so that it would seem to take away the last excuse of those roads who build mere boxes for suburban stations, except that, of course, they are their own architects—they save these fees. But the old saying, "A man who is his own lawyer is apt to have a poor attorney," may be verily applied to the matter of architecture.

SPECIAL TOOLS OF THE PHILADELPHIA & READING RAILROAD.

TICKET-DESTROYING MACHINE.

HERETOFORE the tools and machinery which we have illustrated, as connected with or built by the shops of the railroads, have been intended solely for use in the shop, lessening the cost of labor on some special class of work. The shops of the Philadelphia & Reading Road, however, have not confined themselves to improvements within their own domain, but have built other machines which are intended for use along the line of the road or for special purposes, wherein they found that they could do this more economically than the regular builders. Among such tools is the ticket-destroying machine, of which we give complete illustrations.

The plan, side and front elevations of the machine give a very complete idea of its general construction, and it will be seen to be exceedingly simple. The idea of the machine is that the tickets to be destroyed are put into the hopper over the pair of mandrels provided with cutting teeth, and these, revolving in opposite directions, carry the tickets down in between them, and mutilate them to such an extent that it would be impossible to use them a second time, delivering them into the tin shute shown below the base of the machine, on to the floor or into a basket. It will be seen that the framework is of wood, and that the motive power is derived by a treadle driven by the foot of the operator and steadied by a heavy fly-wheel, with a belt running up to the arbor of one of the cutters. Spur-gears meshing with each other drive the second arbor, and this is practically all there is of the machine.

In order that others who may feel interested in the duplication of such a tool can do so, we have given a very complete set of measurements, that the size can be readily seen.* Of course where power is available the treadle and fly-wheel are dispensed with, and the belt will be carried down to a pulley on the main arbor from an ordinary countershaft.

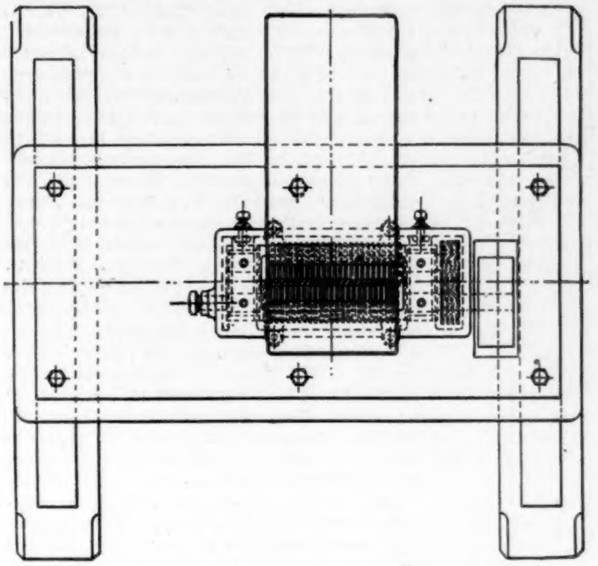
CARRIER FOR WHEEL LATHE.

Any one who has to do with the adjustment of driving-wheels in the double-headed wheel lathe knows how difficult it is to secure an adjustment so that the bearing of each face-plate is steady and even against the wheel next to it. It is sometimes the labor of hours to get the wedges so driven that each driver is doing its own portion of the work, and that the spring of the axle is not carried from one wheel to the other, causing a chatter which renders it impossible to turn the wheel smoothly. The driver which is shown is of very simple construction, and is bolted into position on the wheel lathe through the ordinary slots with T-headed bolts, so that it has an approximate bearing. That portion of the driver which comes within the hub is eccentric with the outer part, and is of a smaller diameter, and it is, therefore, merely necessary, after an approximate adjustment has been made, to turn it until a solid bearing of the driver against the hub is obtained, and then to hold the driver in that position by the set screw shown

at the side. After starting the lathe, if it should be found that one driver is doing more work than the other, owing to the carelessness or difficulty in bringing both up to exactly the same stress of bearing, one driver can be moved ahead or the other slackened back according to the judgment of the workman.

THREE-CYLINDER ENGINE.

Most engineers are familiar with the wonderful work which has been done by the three-cylinder Brotherhood engines for high speed, which are running dynamos and other rapid running machinery direct from their own shafts. Among the

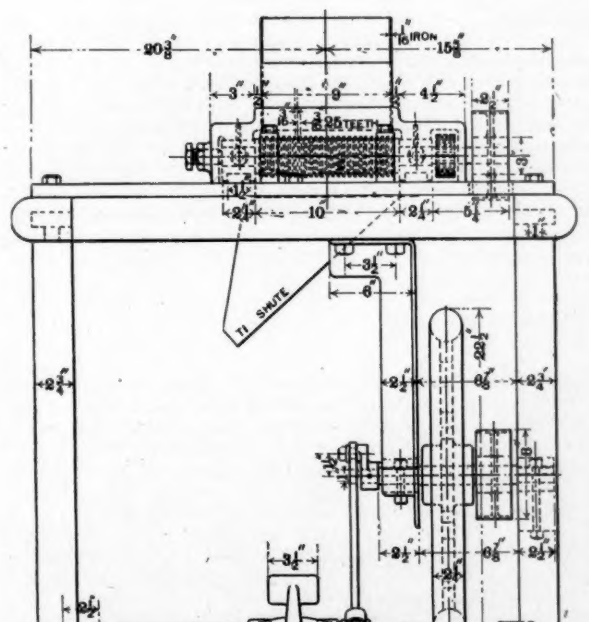


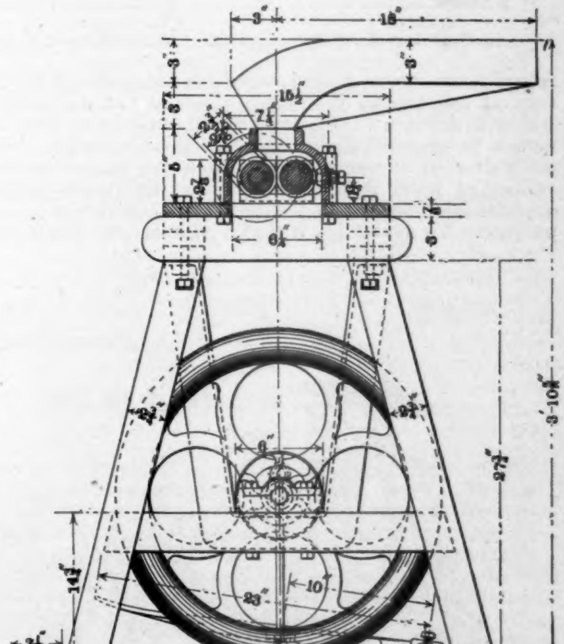
interesting little tools in the shop of the Philadelphia & Reading Road is the three-cylinder engine, of which we give illustrations. It is a single-acting engine with trunk cylinders set at an angle of 120° with each other. The cylinders have a diameter of 2 in. with a stroke of 2 in. They are lined with steel bushings, and the trunk packed with steam packing of the ordinary type. The valve is arranged at the end of the shaft, and admits and exhausts the steam consecutively from the three cylinders. This particular engine is mounted on trucks, and is carried about the shop to be used wherever steam power is desired. Among the uses to which it is put is the boring out of holes, reaming holes in frames, etc. One of them is in constant use in boring out cylinders. In all cases except the latter they are connected with Stowe flexible shafts, which in turn are connected to portable drilling or boring attachments. The engine, as will be readily seen, is simple and cheaply constructed, and is very readily handled and adapted to all the various uses of a large shop where portable power is required.

PUMP VALVES.

At a recent meeting of the Institute of Marine Engineers Mr. W. E. Lilley read a paper on "Pump Valves."

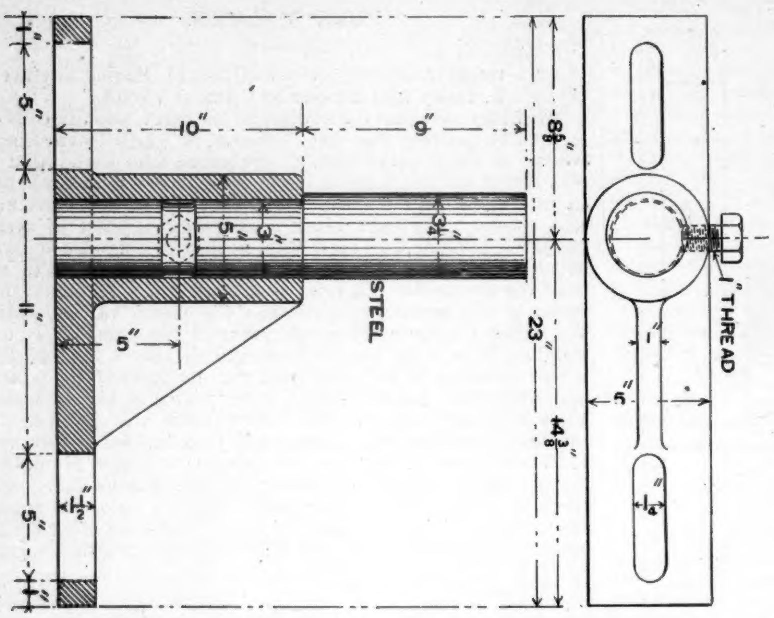
Mr. Lilley said that the subject of his paper, usually considered an elementary one, was, however, of much interest, and worthy of the consideration of engineers, who found that it was rather by attention to detail than to any radical change in the design of the engine itself that the highest efficiency was obtained. Pumps being a necessary adjunct to every condensing engine, and absorbing, as they did, a large amount of mechanical power, engineers naturally endeavored to reduce the loss under this head to a minimum. To obtain this result it was necessary to consider the pump valves, which had so much to do with the efficiency of the pumps. To determine, then, what was the best style of valves for a pump, it was necessary to consider what was required of the pump, and what were the conditions under which it had to work. First he would deal with the different kinds of pumps. In this paper reciprocating pumps had been classed as follows: 1. Plunger pumps, such as feed pumps; 2. Piston or double-acting pumps, such as combined steam pumps and some forms of circulating pumps; and 3. Bucket pumps as generally used for air and circulating pumps. Among other desiderata required for pumps, the following were practically general for all; they should have a good efficiency under varying conditions of speed and work; they should run free from noise and shocks, and require few repairs. Water in all cases had been assumed as the liquid to be pumped, its viscosity being neglected. Referring to the piston pump, a drawing of which was given with the paper, the author said that the piston speed in feet per minute would be equal to the stroke in feet multiplied by the number of strokes per minute. This was the average piston speed, if the piston was supposed to be



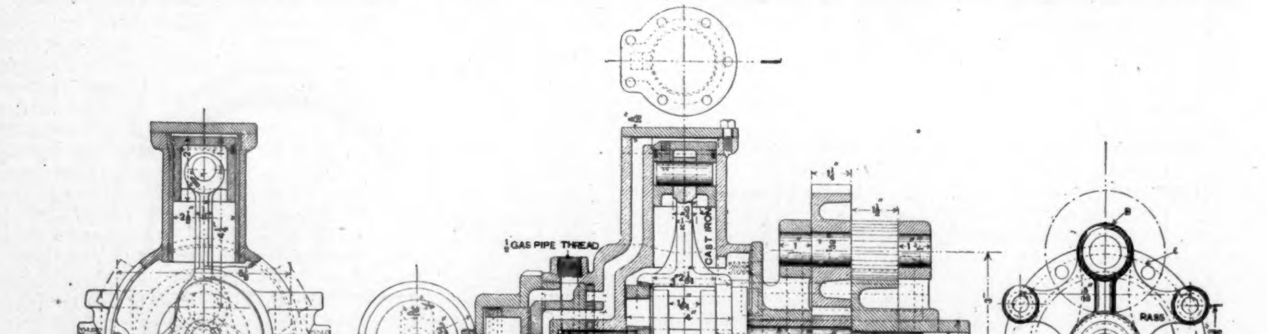


TICKET-DESTROYING MACHINE, PHILADELPHIA & READING RAILROAD.

connected similarly as the steam piston was to a shaft rotating uniformly. The speed would vary from nothing at the commencement of the stroke to a maximum toward the middle of the stroke, and this maximum could be shown to be approximately half as much again as the average speed. The above applied equally to plunger or bucket pumps. Calling attention to drawings of a piston and a plunger pump, Mr. Lilley said that if the valves were supposed to be arranged as there shown, and the stroke just commencing, water would flow into the pump tanks to the difference of pressure in the pump chambers and the outside source of supply. Similarly on the return stroke, water flowed out of the pump due to the difference of pressure in the pump chamber and the vessel into which it delivered. This volume of water was then set in motion in opposite directions every double stroke. Should the valves be at some distance from the pump chamber, a volume of water in the passages was also set in motion in opposite directions every double stroke, and this to no useful purpose. To avoid this it was advisable, and might also be stated as an axiom, that there should be as little clearance as possible between the pump chamber and the valves. Some objections might be raised that the water exterior to the pump had also to be set in motion, and that the closeness of the valves was not of such consideration. To overcome this it was usual to fit air vessels close to the valves, or to arrange that the water in the supply and delivery should be continually flowing toward and from the pump chamber respectively, the object in both cases being to give motion to as small a quantity of water as possible, beyond that required by the pump at each stroke. Another reason for having as little clearance as possible, which was specially applicable to air pumps, was that the clearance space, by allowing vapor to form, caused the efficiency of the pumps to be impaired. The positions of the valves with regard to the pump chamber might be multiplied almost indefinitely, and dependent in a great measure on the position of the pump itself, the valves being usually arranged so that their own weight helped to close them. Some pumps were made with a pump chamber of larger size than the plunger, so that a volume of idle water was in the pump. By this means it was possible to overcome the objections of having a volume of water reciprocating to and fro in the passages, and at the same time secure favorable positions and plenty of space for the valves which could be arranged on the pump chamber itself. The disadvantage this had was that in pumping hot water, if the difference of pressure between the pump chamber and the supply or delivery was appreciable, vapor was formed and impaired the efficiency of the pump. In reciprocating piston and plunger pumps the continual change of direction of the water in and out of the pump chamber acted disadvantageously against any great piston speed. If the piston in the drawing of the piston pump be supposed to be moving with a quick speed, the difference of pressure between the pump chamber and the outside source of supply would be greater than if it were moving with a slow speed. This difference of pressure would vary approximately as the square of the speed. The water, owing to its inertia, would also have to be acted upon for an appreciable time by this difference of pressure, to give it the required velocity of flow into the pump chamber. Suppose, then, the piston speed to be continually increased, a speed would be arrived at in which the pump chamber would be only partially filled with water, the water not having time to acquire sufficient velocity to follow the piston. Suppose such a case to have happened, that the pump chamber was about half filled with water on the return stroke, the piston descended and met the water, it would at this moment have its maximum velocity during the stroke, and all the water in the pump chamber would have to acquire this velocity instantaneously, together with the pressure necessary to drive it through the valves into the delivery. Something, then, in the nature of a blow would take place, and it was due to this cause that the difficulty of making high-speed piston pumps arose, the strains on the working parts being largely increased as the speed increased, and the pump falling off in efficiency. Bucket pumps had a great advantage as



CARRIER FOR WHEEL LATHE, PHILADELPHIA & READING RAILROAD.



THREE-CYLINDER ENGINE, PHILADELPHIA & READING RAILROAD.

compared with piston or plunger pumps in this respect. The direction of the flow never changed, and the difference of pressure required was only that necessary to drive the water through the valves. Supposing a similar case to occur as in the piston pump, that the pump chamber was only half filled with water, on the bucket meeting the water only the surface of the water was affected, thus relieving the pump and permitting of a more efficient pump at high piston speeds. Having thus briefly determined the working of the pump, the best conditions for the pump valves would now be considered. The area through the valve-seat should be as large as possible. Various authorities gave the velocity of flow through the valves from 400 ft. to 600 ft. per minute, which corresponded to a difference of pressure from 1 lb. to 2 lbs. between the pump chamber and the source of supply or delivery. In designing the area through the valve-seats the conditions under which the pump would be required to work must be considered, since for the water to flow into the pump an amount of energy had to be expended in giving the necessary velocity to the water to flow into the pump, and this energy expended varied as the square of the velocity. If the strokes per minute were constant, the expended energy would also have to be given to the water in equal times. It followed that the difference of pressure would vary as the square of the velocity. From this, then, it would be evident that in fast running pumps the area through the valves should be as large as possible. The area through the opening due to the lift of the valves should be equal to the area through the valve-seats. This might almost be said to be self-evident, and yet it was one of those things most overlooked in pumps, the lift, as a rule, not being sufficient. The real area through the valves in this case was the opening through the lift of the valves, and the area of the valve-seat might be reduced to that area without throwing any more work on the pump. The valves should always be as light as possible. Referring to the drawing of the piston pump, if the piston be supposed to be just at the commencement of the stroke, the delivery valve closed, and the suction-valve just upon opening, it would require a certain amount of energy to move the valve off the seat. A small portion of the stroke would take place before there was any motion of the valve; then, owing to the increasing difference of pressure, the valve moved with an increasing velocity till it met the stops, giving up its energy of velocity in striking the stop. This kinetic energy would be proportional to the weight of the valve and to the square of the velocity. Similarly on the down stroke the valve closed, striking the seat, but in this case its kinetic energy might be greater, owing to the fact that the pressure in the pump chamber rapidly augmented to drive the water through the delivery valve, and the action of the delivery valve would be precisely the same. If, then, the valve be heavy, it followed that the wear and tear due to hammering or striking would be great, also that the valve itself would be sluggish, owing to its inertia. To avoid this, then, the valves should be as light as possible. The lift of the valves should be small. Suppose a pump having valves whose weights were the same, but one valve with twice the lift of the others, the valve with the greater lift would have the greater velocity on striking the stop or valve-seat, and its kinetic energy would be approximately twice as much as the one with the smaller lift. It was also important for the valves to open and close quickly, and the less the lift the better would these conditions be satisfied. The diameter of the valves should be small, annular, or the equivalent of having several small valves in one. The area of the valve-seat varied as the square of the diameter, while the lift of the valve remaining the same, the area of the opening varied as the diameter only. Therefore if the diameter of the valve be doubled it was necessary to double the lift. The above conditions gave some guide in determining the best forms for valves, but much was still left to the discretion of the designer in choosing that valve which would give the best results according to the conditions under which the pumps would have to work. The plethora of good valves now before the public, each having some special merit, made the choice of the one to be selected for a particular purpose one of great nicety and discrimination. The pioneer engineers in the early days of steam used leather valves, commonly known as the flap or butterfly valves. These then gave way to metal flap valves, the idea of the flap seeming obviously to have been taken from the leather valves then in use, and no doubt these valves worked well in the days of low pressure and slow piston speeds. The rubber valves were next introduced, and so long as they had not to pump against any great pressure, and were kept free from oil, left little to be desired in their working, even to the present time holding their own in circulating and such like pumps. Oil having a solvent action on the rubber, they were found to rapidly deteriorate in the air pumps. Attempts had been made to make the rubber impervious to oil, but up to the present unsuccessfully. Vulcanite, a hardened preparation of rubber, fiber, asbestos, cast-metal valves of various types, and thin rolled phosphor bronze sheets followed, the tendency being as the piston speeds and pressures kept on increasing for the valves to be lighter and of stronger section. The author then proceeded to refer in detail to the special features of the best-known valves now in use, and, in conclusion, said he hoped that members would contribute particulars of any further valves which might not have been mentioned, so that the information furnished as to available pump valves might fairly cover the ground as represented by modern practice.

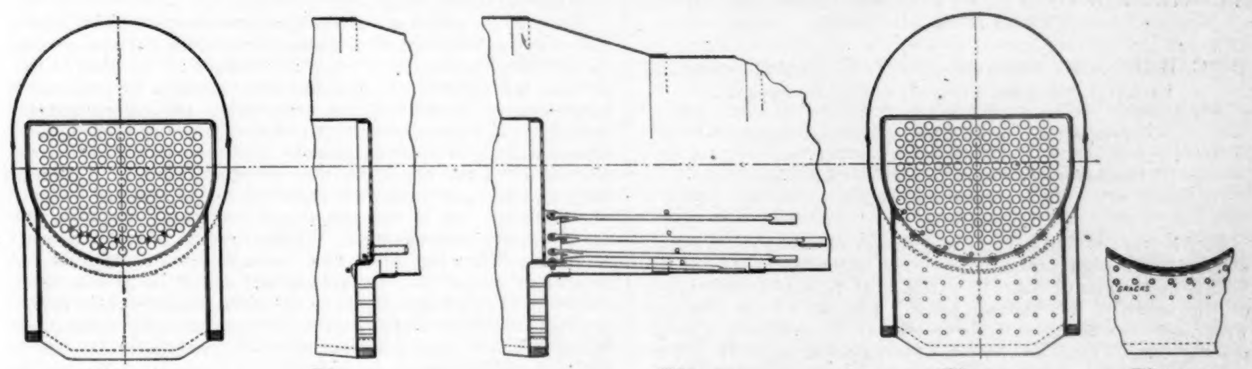


Fig. 1. Fig. 2. Fig. 3. Fig. 4. Fig. 5.

DIAGRAM OF CRACKS IN FIRE-BOX SHEETS.

CRACKS IN FIRE-BOX SHEETS.

At a recent meeting of one of the committees of the Master Mechanics' Association, Mr. David Brown, who is Master Mechanic of the Delaware, Lackawanna & Western Railroad Company, at Scranton, Pa., submitted a drawing showing the sections of boiler and fire-box, and points upon it marked that were most liable to crack and bulge. This drawing we reproduce in our engravings, and would call attention to the fact that it contains a modification of the ordinary form of boiler construction which has been adopted by Mr. Brown, for the purpose of overcoming the difficulties which are most common with the locomotive form of boiler. Fig. 1 shows a cross-section through the fire-box of a boiler, and the points in flue-sheet marked *A* are those points which are most likely to crack. This flue-sheet is shown without any bracing, and a longitudinal section of the same is given in fig. 2, showing how likely it is to be sprung by expansion at the point *B*. It does not necessarily follow that the bulge and deformation shall be as great relatively to the rest of the boiler as it is shown here, but the tendency is as represented. Fig. 3 shows a design of flue-sheet which Mr. Brown is using, and which is intended to prevent the springing illustrated in fig. 2.

It will be seen that the lower portion of the front sheet has the flange carried back beyond the face of the tube-sheet, and to this the braces *C* are pinned with their other ends riveted to the sheet of the boiler.

The cross section of the same boiler is shown in fig. 4. The

points marked *D* being the attaching points to the flue-sheet, eight of these are used and the trouble is practically overcome. It will be seen that with the ordinary fire box, as shown in fig. 2, the distance between the top stay-bolt in the front flue-sheet and the bottom tube is considerable, and that as the tube is held by the friction of the expanded portion and the bead, the strain at that point must be far greater than that which should, in good practice, be put upon the tube. By distributing these stays along the bottom of the sheet, as we have shown them, the strain on the tube-sheet is brought down to the normal point. The additional expense of doing this work is simply that involved in the making of the braces and putting them in position, for no more iron would be required for the deep flange, as shown on the improvement, than on the old, except that there would be a little less scrap left from the sheet.

Fig. 5 gives a partial outside view of the throat-sheet, showing the cracks about the upper stay-bolts *F*, which are caused by the strain on the sheets when the braces at *D* are not used. Every master mechanic knows the trouble which he has with leaky throat-sheets, and the cracks which are so liable to form around the upper stay-bolts, so that the braces which are used here serve the double purpose, not only of preventing the tube-sheet from becoming distorted and cracked, but also protects the throat-sheet from the annoying cracks that are likely to appear around the upper stay-bolts.

CONTRIBUTIONS TO PRACTICAL RAILROAD INFORMATION.

Chemistry Applied to Railroads.

SECOND SERIES.—CHEMICAL METHODS.

VI.—METHOD OF DETERMINING PHOSPHORUS IN PHOSPHOR BRONZE.

By C. B. Dudley, Chemist, and F. N. Pease, Assistant Chemist, of the Pennsylvania Railroad.

(*Continued from page 578, Volume LXVII.*)

OPERATION.

Put 1 gram of fine borings in a beaker about 2½ in. in diameter by 3½ in. high, and add 25 c.c. of aqua regia. Cover the beaker and allow to dissolve; then heat to near boiling point of the solution for half an hour. Add 25 c.c. of distilled water and then 20 c.c. of concentrated C. P. ammonia, specific gravity 0.90. Then add 50 c.c. of ammonium sulphide. The principal portion of the copper and lead is precipitated as sulphides, and the tin and phosphoric acid are in solution, which is a clear yellow. Digest at a temperature near the boiling point of the solution for 20 minutes. Allow to settle, then filter through a 9-cm. filter into an Erlenmeyer flask, holding about 300 c.c. The filtration and washing is best managed as follows: Pour the clear liquid on the filter, and allow most of it to run through. Then pour the remaining liquid along with the precipitate on the filter, and allow everything that will to run through. Put the filter with the precipitate on it back into the beaker, and add 50 c.c. of the ammonium sulphide wash water. Warm and stir occasionally for 10 minutes to secure as complete solution and diffusion of the soluble material as possible; then pour everything on another filter and allow all that will to run through. Then wash on the filter with about 50 c.c. more of the ammonium sulphide wash water. This gives a volume of filtrate of about 200 c.c. Add now to this filtrate 10 c.c. of magnesia mixture, and shake to secure uniform diffusion of the precipitant. Put the flask in ice water and allow to stand in same with occasional agitation for two hours. Filter through a 7-cm. filter, and wash with ammonia wash water only until the washings react slightly with silver nitrate. Then add 10 c.c. of dilute hydrochloric acid to the flask, and so manipulate that the liquid touches all parts of the inside of the flask and dissolves any adhering precipitate. Then with the liquid in the flask dissolve the precipitate on the filter, allowing the solution to run into a small beaker. Wash the flask and filter with the same dilute hydrochloric acid until the volume of the filtrate is about 30 c.c. Add now 5 c.c. of magnesia mixture and 10 c.c. of concentrated C. P. ammonia 0.90 specific gravity; agitate by stirring, put in ice water, and allow to stand with occasional stirring for two hours. Filter on a 5-cm. filter, wash with same ammonia wash water, until the washings react only slightly opalescent with silver nitrate. Smoke off the filter, ignite until the precipitate is white, and weigh.

APPARATUS AND REAGENTS.

The apparatus required by this method needs no special comment.

The aqua regia is made of equal parts nitric and hydrochloric acid by volume, both concentrated C. P.

The C. P. ammonia is obtained in the market, specific gravity 0.90.

The ammonium sulphide solution is made by treating C. P. ammonia, specific gravity 0.90, with H_2S until no further absorption takes place, and then adding two-thirds as much by volume of the same ammonia to the solution. It is only slightly yellow in color, and may usually be obtained in the market.

The ammonium sulphide wash water is made by adding three parts of distilled water to one part of the above solution, both by volume.

The magnesia mixture is made by dissolving 66 grams of crystallized C. P. magnesium chloride and 168 grams of C. P. ammonium chloride in 780 c.c. of distilled water, and adding 420 c.c. of C. P. ammonia, specific gravity 0.96. Allow to stand two days and filter.

The ammonia wash water is made by adding to 800 c.c. of distilled water 200 c.c. of C. P. ammonia, specific gravity 0.90, and 25 grams of crystalized C. P. ammonium nitrate. Filter before using.

The dilute hydrochloric acid is made by adding 1 part concentrated C. P. acid, specific gravity 1.20, to 4 parts distilled water, both by volume.

CALCULATIONS.

The atomic weights used are magnesium, 24; phosphorus, 31; oxygen, 16. The molecular formula of magnesium pyrophosphate used is $Mg_2P_2O_7$.

Since 27.93 per cent. of the magnesium pyrophosphate is phosphorus, the amount of phosphorus in the precipitate may be obtained by the proportion $a : b :: 0.2793 : x$, in which a represents the amount of phosphor-bronze taken to start with, expressed in grams; b, the magnesium pyrophosphate obtained, also expressed in grams; and x the phosphorus sought, which will likewise be in grams. Then, since the above proportion gives the actual amount of phosphorus in 1 gram or part of phosphor bronze, it is obvious that the per cent. of phosphorus—that is, the amount in 100 grams or parts, will be 100 times this amount. Where 1 gram is taken to start with, the following brief rule may be used: Express the weight of magnesium pyrophosphate found in grams, move the decimal point two places to the right, and multiply by the decimal 0.2793. Thus if the magnesium phyrophosphate found is 0.0304 gram, the per cent. of phosphorus is (3.04 × 0 2793) 0.849 per cent.

NOTES AND PRECAUTIONS.

It will be observed that this method oxidizes the phosphorus by means of nitric acid, with hydrochloric acid present to hold up the tin; separates the phosphoric acid from the lead and copper by means of ammonium sulphide, and precipitates the phosphoric acid as ammonium magnesium phosphate in presence of tin and ammonium sulphides, the precipitate being purified by a second precipitation before weighing.

The aqua regia used contains more nitric acid than is customary for this reagent. Nitric acid alone would possibly be as good or perhaps better to oxidize the phosphorus, but experience shows that the meta-stannic acid formed when nitric acid alone is used dissolves in the ammonium sulphide with some difficulty. Incomplete solution would of course result in loss of phosphorus. Accordingly some hydrochloric acid is used to bring the tin into solution. With the method as recommended, there is no difficulty with the tin.

Heating the aqua regia solution for half an hour after the metal is in solution secures complete oxidation of the phosphorus, and the addition of the water dilutes the acid sufficiently so that the strong ammonia can be added without too violent reaction.

If the ammonium sulphide used is made as recommended, very little if any of the copper sulphide is dissolved. Strong yellow sulphide of ammonium gives more difficulty from this cause; and if the yellow sulphide is used, the first ammonium magnesium phosphate precipitate may be contaminated with copper sulphide, which has separated during the two hours in the ice water. This copper sulphide may not cause subsequent difficulty, but it is better not to have it present.

The 20 minutes' digestion after the ammonium sulphide is added, and the filtration and washing recommended, success-

fully remove the phosphorus from the lead and copper sulphides. An examination of these sulphides by decomposing them with nitric acid, separation of the lead as sulphate, then separation of the copper as sulphide in acid solution by means of H_2S after partial neutralization of the free acid with ammonia, concentration of the filtrate to small bulk, and testing with molybdate of ammonia solution shows only a trace of yellow precipitate.

It is desirable to have the bulk of solution in which to precipitate the phosphoric acid by magnesia mixture as small as may be, on account of the possible solubility of this precipitate. At the same time the lead and copper sulphides are so gelatinous that complete washing on the filter is difficult. The procedure recommended apparently secures the result desired with the least amount of wash water. The following experiment has been made on this point. When the ammonium sulphide solution is ready to filter, the total bulk due to reagents added should be 120 c.c.; but on account of evaporation and decompositions the actual bulk was 109 c.c. Of this 101 c.c. ran through the filter after the clear liquid and precipitate had been put on the filter as directed. After putting the precipitate and filter back into the beaker, adding 50 c.c. of ammonium sulphide wash water, and digesting covered for 10 minutes, the bulk of solution, including the filter, was 59 c.c. Of this 48 c.c. ran through the second filter. Neglecting the volume of the precipitate, and assuming that the phosphoric acid is uniformly disseminated in the liquid, it is evident that eight-one hundred and ninths of the phosphorus is left behind after the first filtration and eleven fifty-ninths of this after the second filtration. Reducing these fractions, it appears that after all that will has run through the second filter, only 1.37 per cent. of the phosphorus is left behind. As phosphor-bronze usually contains less than 1.00 per cent. of phosphorus, it is obvious that only about one hundredth of a per cent. of phosphorus remains to be washed out. The 50 c.c. of wash water recommended is apparently abundant for this purpose. In the above experiment the measurements, when the precipitate was present, were made in the beaker, and must be regarded as close approximations only.

The use of a flask for the first precipitation offers some advantages over a beaker, the principal one being that the ammonium sulphide is less exposed to the air, and consequently undergoes less change, with resulting less probability of throwing down free sulphur or traces of sulphide of copper than if a beaker is used. The flask should be covered with a small watch glass, but it is not necessary to use a cork or a glass rod for stirring.

Over-washing of the ammonium magnesium phosphate is to be avoided as carefully as under-washing. The directions given should be closely followed.

The precipitation of the phosphoric acid by excess of magnesia mixture, in presence of the tin and ammonium sulphides, seems to be fully as satisfactory as in the presence of chloride of ammonium alone. An examination of the filtrate and washings from the first precipitation by evaporation nearly to dryness, taking up with nitric acid with just enough hydrochloric to hold up the tin, and testing with molybdate solution, shows only a trace of yellow precipitate.

It is not advisable to weigh without the second precipitation. Although careful manipulation and the use of almost colorless ammonium sulphide may avoid contamination from copper sulphide, there is always danger of free sulphur in the ammonium magnesium phosphate. For good work the second precipitation should never be omitted.

Ammonium magnesium phosphate is liable to be reduced during the ignition of the filter, and thus lead to slightly low results. To obviate this difficulty, the filter and precipitate are put into the crucible wet, and the filter "smoked off" and then burned. The "smoking off" consists in applying the heat to the wet material in the crucible so slowly that the volatile matter of the filter passes off without ignition, free access of air being maintained at the same time. To accomplish this, fold up the wet filter with the precipitate in it, and place it in the crucible. Put the crucible on the triangle as in ordinary ignitions, and leave the cover off. Then heat the open end of the crucible slowly. The filter and precipitate gradually dry, and soon the parts of the filter in contact with the crucible begin to distill off the volatile matter at low heat, even before the whole is dry. This process goes on if the flame is properly adjusted, until in a little while everything that is volatile at a low temperature has passed away, and the precipitate, with a black envelop of carbonaceous matter, is left. When this is the case the temperature can be raised, the lamp moved back to heat the bottom of the crucible, and the carbon burned off completely. Usually when the temperature is raised, the black envelop of carbonaceous matter falls away from the precipitate and is rapidly consumed. By this method of ignition the material is a little longer time in the crucible than with the old method of previously dried precipitates, but the danger of reducing the precipitate is believed to be very much diminished. The small amount of nitrate of ammonia in the ammonia wash water left in the filter paper facilitates this operation.

When a bronze contains only small amounts of phosphorus, it is advisable to start with 2 to 5 grams. The manipulation and proportions of reagents are, however, the same except that 75 c.c. of ammonium sulphide should be used for the first addition, and 75 c.c. of ammonium sulphide wash water for the second addition, and about 100 c.c. of the same wash water for washing on the filter. This gives a bulk of about 300 c.c. for the first precipitation.

It seems probable that the method described above in careful hands will give results accurate to about one hundredth of a per cent., although it is not rare that duplicate determinations on the same sample differ two hundredths. Where proper care is given to each point, it takes about seven hours to get a result.

MORE ROOM NEEDED.*

SECRETARIES of the Interior and Commissioners of Patents again and again have given voice to the crying need for more breathing space for the men and women who work in the Patent Office; and however much of sameness it may entail, an ever-present menace to the health and safety of these people makes the imperative duty of this report to present this matter again and first of all. On high authority an office occupant needs 4,000 cub. ft. of air space in a room having "ordinary ventilation," which he occupies two successive hours. Two hundred and seventy people in the examining force of this Bureau have but 900 ft. of air space each, in rooms which they occupy for seven consecutive hours, and 110 persons in the assignment and draftsman's divisions have less than 500 ft. of air space each, in rooms which they occupy for the same length of time, and the ventilation is not "ordinary;" it does not rise to that dignity.

Originally the corridors in the Patent Office building ran to the exterior walls, where there are windows admitting light and air; but supposed necessity has since located a room at each extremity, converting the corridors into dead-air spaces, needing artificial light at noonday. The corridor-walls are lined on both sides with unsightly wooden closets and file-cases filled with record-papers. A great number of the force work in basement and sub-basement rooms, intended simply for storage purposes in the original planning of the building.

There are stored more than 1,000 tons of copies of patents on five different floors, tucked into every nook and corner where an eager eye can discover a few feet of available space, so disconnected in order and arrangement that it not infrequently happens that, to select two copies standing next each other in number, one must travel from the sub-basement to the galleries, four stories above. These copies are stored upon these galleries beyond the limit of safety, the worst overloading being directly over the Commissioner's room, and in that near vicinity the cracking of the roof-supports gives daily evidence of the danger which constantly threatens all below.

The situation is serious. It is one which in reason demands immediate relief. The present Secretary of the Interior, commenting in appreciative and generous phrase upon this matter in his letter to the President of the Senate, dated March 18, 1892, says:

> It is imperatively necessary that the Department of the Interior should be granted a public building in which to do its works and preserve its archives commensurate with the important service demanded and the great national services devolved upon it. As it is, burdens of material are not only heaped upon the buildings the Department occupies beyond their strength, but burdens of labor are imposed upon the officials, without regard to human endurance.

It would seem that no reasonable question can be made but that the permanent solution of the difficulty is thus correctly stated; but the Patent Office ought to have relief meanwhile. The immediate relief which is possible, and which Congress has apparently approved in the past, is the present and entire removal of the General Land Office from the structure commonly known as "the Patent Office building."

By act approved March 3, 1887, it was enacted:

> That as soon as practicable after the completion as provided for in the sundry civil act approved August fourth, eighteen hundred and eighty-six, and not later than December first, eighteen hundred and eighty-eight, the Secretary of the Interior shall cause to be removed to the Pension Building the General Land Office, Bureau of Education, Office of Commissioner of

* Report of the Commissioner of Patents for 1892.

Railroads, and Bureau of Labor, and vacate the buildings rented for and now occupied by said offices and Bureaus, or portions thereof.

But under the act approved October 2, 1888, it was

Provided further, That so much of the act approved March third, eighteen hundred and eighty-seven, as requires the removal of the General Land Office and the Bureau of Education to said Pension Building be, and the same is hereby repealed.

Congress, however, said this by act approved March 3, 1891 :

For rent of buildings for the Department of the Interior—namely, for the Bureau of Education, four thousand dollars : Geological Survey, ten thousand dollars ; Indian Office, six thousand dollars ; General Land Office, sixteen thousand dollars ; in all thirty-six thousand dollars.

It is understood that less than $5,000 of the $16,000 thus appropriated for the rent of the General Land Office was used.

Congress shall have power . . . to promote the progress of science and useful arts by securing for limited times to . . , inventors the exclusive right to their . . . discoveries.

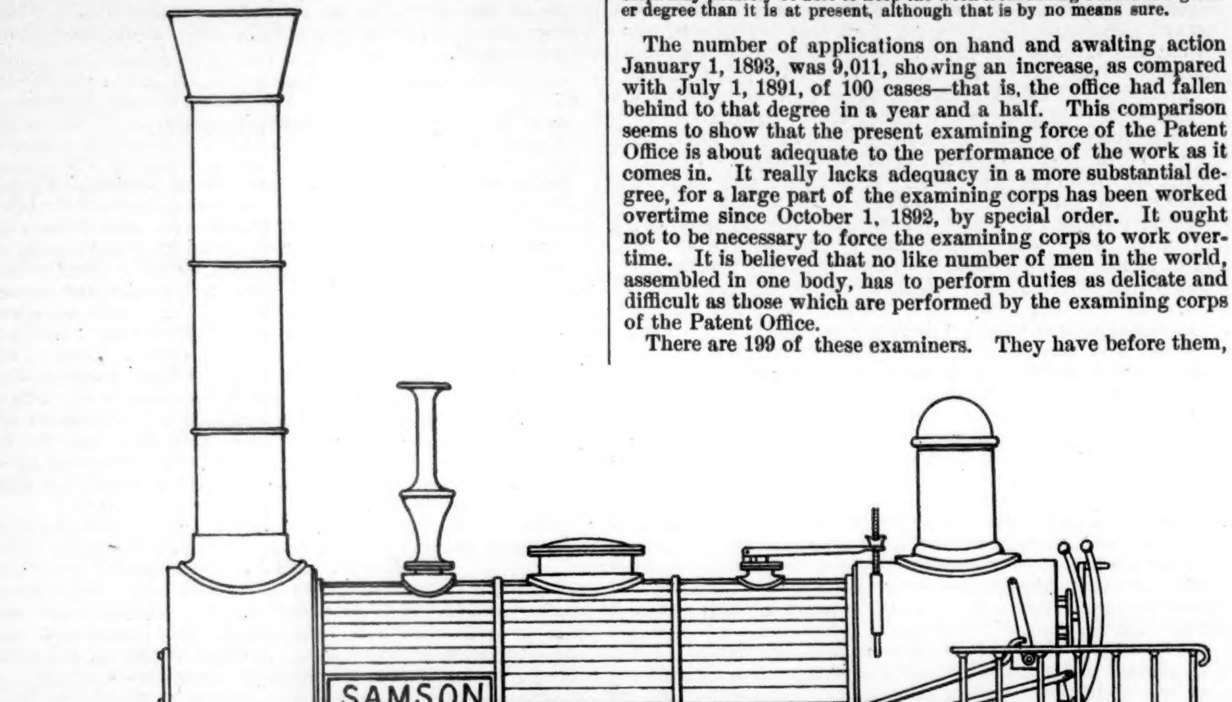
MORE FORCE NEEDED.

The number of applications for patent on hand and awaiting action July 1, 1890, was 6,585 ; the number July 1, 1891, was 8,911. During that year the work fell behind 2,326 cases. At the latter date 10 persons were added to the examining corps and four persons to the clerical force. The present Commissioner began his duties August 1, 1891. His last annual report—that for the year ending December 31, 1891—said :

Within the latter half of the year just passed ten persons have been added to the examining corps and four persons to the clerical force of the Patent Office, under provision made for that purpose by the last Congress, and that addition is a most grateful one. But it is not all that is needed. The experience of the last few months shows that the present examining corps may possibly be able to keep the work from falling behind to a greater degree than it is at present, although that is by no means sure.

The number of applications on hand and awaiting action January 1, 1893, was 9,011, showing an increase, as compared with July 1, 1891, of 100 cases—that is, the office had fallen behind to that degree in a year and a half. This comparison seems to show that the present examining force of the Patent Office is about adequate to the performance of the work as it comes in. It really lacks adequacy in a more substantial degree, for a large part of the examining corps has been worked overtime since October 1, 1892, by special order. It ought not to be necessary to force the examining corps to work overtime. It is believed that no like number of men in the world, assembled in one body, has to perform duties as delicate and difficult as those which are performed by the examining corps of the Patent Office.

There are 199 of these examiners. They have before them,



LOCOMOTIVE FOR THE MANCHESTER & LIVERPOOL RAILWAY.

BUILT IN 1831 BY R. STEPHENSON & CO., NEWCASTLE-ON-TYNE.

Now that the business of the Land Office is radically diminishing, and in the nature of things must soon become a small matter and so remain, while the business of the Patent Office steadily increases and must continue so to do, the attention of Congress is earnestly called to this mode of relieving the Patent Office from its great trouble. In this connection it is fair to say that the entire structure now occupied in part by the Patent Office was planned as a Patent Office, and its construction begun under an act approved July 4, 1836. Hundreds of thousands of dollars of patent fees have been incorporated into that building, and inventors have now lying in the United States Treasury more than $4,000,000, not raised under the taxing power of Congress, but realized under that clause of the Constitution which says that—

in round numbers, 40,000 applications for patent a year, on which are made something over 145,000 separate actions, giving each examiner an average of 730 actions on applications made yearly. In addition to this, they hear and decide a variety of motions, chief among them those for dissolution of interferences, which are argued by counsel, *pro* and *con*, and which require the same study, thought, and deliberation for proper decision as a case in a court of law. They make answers to interlocutory appeals and to appeals on the merits. The principal examiners keep the efficiency records of their divisions, and they keep the data for and render a number of reports. There is a variety of duties performed by the examiners outside of the regular actions on the applications for patents. The United States Supreme Court has repeatedly

spoken of patent law as the "metaphysics of the law," and that it is. A competent examiner must possess a wide range of scientific and technical knowledge, a trained capacity for analysis and comparison of mechanism, a fair knowledge of law in general, and a thorough knowledge of that patent law which the Supreme Court says is the "metaphysics of the law." The code of procedure and practice in the Patent Office is more complicated than that of any court of law, and necessarily so. The necessity inheres in the nature of the work. It is a pleasure to be able to say that the great majority of the examiners in the Patent Office are competent, and to repeat the statement that it is believed that there is no similar number of men in the world, gathered into one body, performing duties as delicate and difficult as those performed by the examining corps of the Patent Office. Men who do work of this character ought not to be obliged to work overtime. Experience in various fields of mental labor has shown that 90 per cent. of all errors are made after five hours of continuous work. The examiners ought to have ample opportunity for thought and deliberation, and the pace asked of them ought to be one that can be reasonably kept from day to day and year to year. Moreover, their salaries, fixed at their present figure a generation ago, should be properly increased.

Something important remains to be said. At the close of the calendar year 1891 the Patent Office had issued 476,271 mechanical patents, constituting a vast field, some particular lines in which have to be explored from first to last in connection with every one of the 40,000 applications for patent which are made each year. At the close of the calendar year 1892 the Patent Office had issued 498,932 patents. Twenty-three thousand new patents are added to this vast field of exploration yearly.

In order to make this exploration possible, the patents are divided into classes. But the classes necessarily so overlap each other that each class needs to be digested by itself, so that each examiner, in passing upon the novelty of an improvement presented for patent, can examine all the classes where he is at all likely to find the improvement in question. Let this proposition be illustrated: One of the examiners of the office, as a matter of private enterprise, lately prepared and published a digest of cycles and velocipedes, making 1,503 pages, contained in two volumes. Under the classification of the office all these improvements are supposed to be found in the sub-classes of Velocipedes and Tires, which are a part of the division of Carriage and Wagons. In order, however, to perfect a compilation, the examiner found it necessary to read from 150,000 to 200,000 patents; comprised in 150 other sub-classes he found devices which it was necessary to include in his digest. Only two or three such digests exist, and they are the product of private enterprise. If all the classes of invention were thus digested, the work of examination into novelty would be wonderfully facilitated, and at the same time made more thorough than is now possible. The situation is such as to demand the making of these digests. It is earnestly recommended that 32 additional fourth assistant examiners (one for each division) be authorized by law expressly for this work; that 16 additional fourth assistant examiners be authorized for the purpose of bringing the current work up to date and keeping it there, and that $25,000 of annual appropriation be made to begin the publication of the digest.

FOR THE GOOD OF THE NATION.

It would almost seem as if there were a halt in the workings of that practical wisdom with which the nation has hitherto treated its inventors. The fathers who builded the Constitution with such rare foresight as to compel the admiration of the world in ever-enlarging degree as we recede from the day in which they wrought, gave Congress the power to promote the progress of the useful arts by securing to inventors for limited times the exclusive rights to their discoveries. The Congress of 1790 promptly made a patent law in pursuance of that power. The Congress of 1793 revised it. The Congress of 1836 broadened the foundations of the system, created the Commissioner of Patents, and ordered the building of the Patent Office, substantially as it now exists. The Congresses of 1842, 1861 and 1870 added features of improvement.

The results have more than justified the constitutional provision and the legislation following in its wake. America has become known the world around as the home of invention. We march in the van of human progress. Now and then a great invention, like the telegraph or the telephone, leaps ahead of the line, but thousands upon thousands of busy inventive brains add each its mite of improvement, and before we know it the whole line has moved out to where the product of mighty genius but a little while ago stood alone. A vastly larger number of inventions are of real value than the great public dreams, and those which seem to fall dead contain within them the seed of suggestion which later lives and grows to rich fruition. There is a sad procession of martyrs mingled with the great inventive host, but the country and the world profit by their sacrifice.

Our inventors are the true nation builders, the true promoters of civilization. They take nothing from the public; they ask nothing from the public; they simply add to the sum of human knowledge, to the sum of human possessions, and to the sum of human happiness. With the Ruler of the universe they share in humble degree His high prerogative of creation, and they but ask to enjoy for a little time the use of the valuable thing they create. The Greeks reserved their highest honors for inventors, and we shall sometime attain to a civilization of like degree.

Into every department of industry and into every possible thing that can conduce to human comfort American inventive genius has entered, to cheapen and to beautify. The Western farmer may know it not, but the inventor of the compound marine engine is possibly the best friend he ever had, and that farmer will find his reward in ascertaining for himself what its effect in cheapening transportation across the ocean has been upon his fortunes. Another example: a single generation ago our carpets were made for us by foreign hands, and the prices were excessive. A great American inventor produced the Bigelow carpet-loom; building upon the faith of an American patent, $1,000,000 in one instance and $1,500,000 in another were risked upon the experiment. The result to day is that our carpets cost about one-third of what they did, and less than one-hundredth of them are made by foreign looms. Had there been no patent law, these millions would never have been risked in the experiment so rich in result to the American people. If to-day the sewing-machine were produced for the first time and we had no patent law, its inventor would hawk it in vain up and down the land to find that foolish man who would risk $500,000 in its commercial development, with the certainty that success would but invite a ruinous competition.

If there be one class of men above all others to whom the American nation and the American people are in debt, it is the American inventors. Why not grant them the poor boon of expending for their benefit the moneys they pay?

LOCOMOTIVE "SAMSON."

We are indebted to Mr. Clement E. Stretton for a blue-print, from which the accompanying engraving was made. This engine was built for the Liverpool & Manchester Railway in 1831 by Robert Stephenson & Co., of Newcastle, and, as Mr. Stretton says, "was just like many sent to America in 1831." Its resemblance to some of the historic locomotives in this country will be recognized. Its cylinders were 14 × 16 in., and the wheels 4 ft. 6 in. diameter.

It is not generally known how many locomotives were imported to this country from England. The following table has, therefore, been compiled from a Report made to the House of Representatives by the Secretary of the Treasury of the United States in 1838. In this report it is said:

"Of the whole number of locomotives in the United States propelled by steam, being about 350, the most which have been ascertained in any State is 96, in the State of Pennsylvania. Those in each State, respectively, can be seen in the table annexed (V 4).

"None of them were introduced here till A.D. 1831, though they now run on nearly 1,500 miles of railroad. The first one, it is believed, was in the State of Delaware, on the Newcastle Railroad; the second, in Maryland, on the Baltimore & Ohio Railroad; and the third, between New Orleans and Lake Pontchartrain, in the State of Louisiana. They had been tried in this country by Oliver Evans as early as 1804, and in England as early as 1805, but not reduced to useful practice in the latter till 1811 for freight, and in A.D 1830 for passengers and speed. One succeeded on a common road, from London to Bath, in 1829. Of the whole number of other steam machines in the United States (being about 1,860), the State of Pennsylvania has the most ascertained, being 383. The number in some States is not accurately ascertained; but near 300 more are ascertained and computed to exist in Louisiana alone. The introduction of them here, and especially with the high-pressure machinery, was much promoted by Oliver Evans about A.D. 1787, in the State of New Jersey, for raising water and earth from mines. The next was about 1791 in a cotton factory at Kensington, near Philadelphia; and soon after in saw-mills and iron slitting and rolling-mills at Pittsburgh."

This report shows how unreliable most history is. The Secretary of the Treasury of the United States is called upon by Congress to make a report, and with all the resources of his

department records that "it is believed" that the first locomotive was introduced here in 1831, in the State of Delaware, on the Newcastle Railroad, whereas there is undoubted testimony that the first locomotive was "introduced," although it was not successful, on the Delaware & Hudson Canal Company's line in 1829.

The following is a copy of Table V 4, referred to in the report of the Secretary:

LOCOMOTIVE STEAM ENGINES IN EACH STATE IN 1838.

LOCOMOTIVES AND RAILROAD ENGINES.

STATES.	Number.	Period when first introduced into use in the State.
Maine	2	1836
New Hampshire	None returned.	
Massachusetts	37	1832
Connecticut.*	....	
Rhode Island	6	1837
Vermont	None returned.	
New York	28	1832
New Jersey	32	1832
Pennsylvania	96	1832
Delaware	14	1831
Maryland	31	1832
District of Columbia†	....	
Virginia	34	1834
North Carolina	5	1836
South Carolina	27	1832
Georgia	3	1837
Florida	2	1836
Alabama	1	1837
Louisiana	10	1832
Indiana, Missouri, and Illinois	None returned.	
Ohio	1	
Michigan	6	1838
Tennessee	None returned.	1836
Kentucky	2	
Wisconsin and Iowa	None returned.	
Aggregate returned	337	
Add as an estimate for those not returned	13	
Total	350	

It is not clear whether "railroad engines" included stationary engines used on railroads or not. Probably it did, so that the number of locomotives in use in this country in 1838 was less than 350.

Following Table V 4 is another which gives the number of "standing engines" in each State; 1,616 are reported and 244 "estimated," or a total of 1,860.

The stationary, steamboat, and "standing" engines in use in different parts of the country are reported separately. From these reports the following table has been compiled, and shows the number of locomotives in use in this country which had been imported from England. The table is probably not entirely complete, but includes 82 locomotives which were in use in this country at that time which were made in England. Wood's "Practical Treatise on Railroads"—third edition—gives a table of locomotives built by Robert Stephenson & Co., which includes a number sent to this country which are not included in our list. Among these is the celebrated *Brother Jonathan* for the Mohawk & Hudson Road. The list is interesting as showing what is not generally known at this time, that in the early days of railroading in this country a large proportion of the motive power was imported from England.

It is also interesting at this time to see the names of American builders of locomotives who were engaged in that business 56 years ago. The following list, made up from the report before us, will probably make some firms known to many of our readers of whose existence they never heard.

LOCOMOTIVE BUILDERS IN THE UNITED STATES IN 1838.

Proprietors Locks and Canal Company	Lowell, Mass.
M. W. Baldwin	Philadelphia.
Newcastle Manufacturing Company	Newcastle, Del.
William H. Norris	Philadelphia.
Seth Boyden	Newark, N. J.
H. B. Dunham & Co	New York.
Rogers, Ketchum & Grosvenor	Paterson, N. J.
Gillingham	Baltimore, Md.
West Point Foundry Company	
Sellers & Sons	
Garrett & Eastwick	Philadelphia.
Rush & Muhlenberg	
Bolton & Co	Boston.
McCluny, Wade & Co	Pittsburgh.
Long & Norris	Philadelphia.
Thomas W. Smith & Co	Alexandria, Va.
Watchman & Bratt	Baltimore.
Eason & Dotterer	Charleston, S. C.
McLeish & Smith	" "
J. Ross	" "
E. K. Dod	New York.

* The locomotives on the Stonington and Providence Railroad are returned to the State of Rhode Island.

† Those on the Baltimore and Washington Branch Railroad are included under the Maryland returns.

THE SCIENTIFIC USES OF LIQUID AIR.

ONE of the largest and most distinguished audiences ever assembled at the Royal Institution crowded the theatre recently to hear Professor Dewar's lecture on the scientific uses of liquid air. They were rewarded with a lecture containing matter that would furnish forth half a dozen ordinary discourses, and opening up questions which years of labor may prove inadequate to answer.

To the majority of people liquid air is only a scientific marvel, to a few it presents a collection of unsolved and most interesting problems, while at the Royal Institution it has become a valuable instrument of physical research. Produced in large quantities and stored by novel and ingenious methods, it is employed in the study of matter at 200° below zero, exactly as a spirit lamp or a gas flame is used in studying the properties of different bodies at temperatures equally removed in the opposite direction from the normal. Professor Dewar's lecture dealt in part with some properties of the liquid itself, which have not previously been studied in equally favorable conditions, but was more particularly concerned with indicating the various important applications of a new and potent instrument of physical investigation.

Liquid air was shown in a condition which, though probably offering nothing novel to the eye of the untrained observer, is yet essentially different from anything hitherto shown on a lecture table. It has always been seen either in a state of active ebullition at ordinary pressure, or of steady evaporation at the lower temperature produced by the action of an air-pump. A few nights ago it was shown as a permanent fluid giving off no gas. Or, to put the matter another way, it has hitherto been shown imperfectly screened from the heat of surrounding bodies, while now it has been placed in such conditions that no extraneous heat could reach it. Formerly its temperature was kept down by its own evaporation, exactly as the temperature of boiling water is kept constant over the hottest fire. As exhibited by the lecturer, its temperature was kept constant without loss of mass. This is effected by placing the liquid in a vacuum jacket, which is immersed in liquid oxygen contained in a second vacuum jacket and connected to an air pump. Convection is annihilated by a vacuum which must be all but absolute, and conduction is shut out by the surrounding oxygen. No access of heat is possible except by radiation pure and simple, and this has already been proved to be, if not non-existent, at all events infinitesimally small. It is an interesting incident of the arrangement that common air can be shown in the solid condition. The importance of the complete isolation of the liquid lies in the fact that exact experiments can be made for the determination of its specific and latent heat. By lowering into the liquid a definite mass of platinum and measuring the gas evolved, it is easy to calculate the heat that becomes latent in converting the liquid into gas. Using similar methods to heat the liquid to a definite extent without altering its condition—*i.e.*, without converting it into gas—the specific heat can be calculated from the variation of pressure as registered by a column of mercury.

Taking a very highly exhausted bulb, containing only a little vapor of mercury at a pressure of one-millionth of an atmosphere, and cooling it with liquid air until that minute portion of metal was frozen solid, the lecturer illustrated the part played in electrical discharges by ponderable matter. In a high vacuum at 200° below zero the difficulty of passing an electric spark in any form becomes almost insuperable. It would not be an extravagant inference from the phenomena were we to affirm that at 274° below zero, when the rarest gas known to us would have suffered condensation, electrical discharge through the frozen void would become altogether impossible. But there are constant warnings in physical science of the danger of pushing inference beyond experiment, at all events in regions where we are approaching the extreme limit of our resources. By enormously increasing its voltage the current may be made to pass even through the frozen-out mercury vacuum; but the discharge assumes a totally different

LOCOMOTIVES USED ON RAILROADS IN 1838 WHICH WERE IMPORTED FROM ENGLAND.

Name of Railroad.	Name of Locomotive.	When Constructed.	By Whom Constructed.	How Long in Use.
		Year.		
Bangor & Piscataqua	Pioneer	1836	Robert Stephenson, Newcastle	Since November 25, 1836.
" "	No. 6	1836	" " "	" " "
Boston & Providence	Whistler	1833	A. L. Stevenson, "	5 years.
" "	Boston	1835	Edward Bury, Liverpool	3 "
" "	New York	1835	George Forester, Liverpool	3 "
Boston & Worcester	Lion	1836	Edward Bury, "	2 "
" "	Meteor	1834	Robert Stephenson, Manchester (?)	4 "
" "	Comet	1835	" " "	3 "
" "	Rocket	1835	" " "	3 "
" "	Mercury	1835	" " "	3 "
" "	Jupiter	1835	" " "	3 "
Boston & Lowell	Stephenson	1832	" " Newcastle	6 "
Saratoga & Schenectady	Fire Fly	1832	Robert Stephenson & Co., England	Since 1833.
" "	Davy Crockett	1833	" " " "	" "
Camden & Woodbury	Fire Fly	1833	C. Tayleur & Co., Liverpool	5 years.
" "	Red Rover	1833	" " "	5 "
Camden & Amboy	No. 1	1832	Swartwout, Liverpool	6 "
Paterson & Hudson River	McNeil	1833	In England	4 "
Philadelphia & Reading	Rocket	1837	Braithwait, London	2 months.
" "	Fire Fly	1837	" "	2 "
" "	Spit Fire	1837	" "	1 month.
" "	Dragon	1837	" "	1 "
Philadelphia & Wilmington	Wilmington	1836	Edward Bury	21 months.
Philadelphia & Columbia	Kentucky	1835	Stephenson	3½ years.
" "	John Bull	1835	"	3½ "
" "	Atlantic	1835	"	3½ "
Newcastle & Frenchtown	Delaware	1831	Robert Stephenson, Newcastle	Since August, 1832.
" "	Pennsylvania	1832	" " "	" November, 1832.
" "	Virginia	1833	" " "	" August, 1833.
" "	Phœnix	1832	" " "	" February, 1833.
Allegheny Portage	Delaware	1833	E. A. Young, Newcastle	4 years.
" "	Allegheny	1834	" " "	3 "
" "	Comet	1837	" " "	1 year.
Baltimore & Susquehanna	Herald	1832	Robert Stephenson & Co., England	6 years.
" "	No. 151	1837	" " " "	Not in use.
" "	No. 152	1837	" " " "	" " "
Richmond, Fredericksburg & Potomac	Roanoke	1832	Edward Bury, Liverpool	6 years.
" " "	Richmond	1834	Robert Stephenson, Liverpool (?)	3 "
" " "	Augusta	1835	Edward Bury, Liverpool	2½ years.
" " "	Fredericksburg	1835	" " "	2½ "
" " "	Potomac	1836	Benjamin Hick, Bolton	2 "
" " "	Louisa	1837	" " "	1½ "
" " "	Jefferson	1837	Summer, Graves & Day, Southampton	½ year.
" " "	John Randolph	1837	Edward Bury, Liverpool	½ "
" " "	Sheppard	1837	" " "	½ "
" " "	Stafford	1837	" " "	½ "
" " "	Patrick Henry	1837	" " "	½ "
" " "	Robert Morris	1837	Rothwell, Newcastle	¼ "
" " "	Oliver Evans	1837	" "	¼ "
Petersburg	Liverpool	1833	Edward Bury, Liverpool	Since 1833.
Greensville & Roanoke	Nottoway	1833	Rothwell & Hick, Bolton	" "
Raleigh & Gaston	Meherrin	1833	Edward Bury, Liverpool	" "
" "	Appomattox	1833	" " "	" "
" "	Staunton	1834	" " "	" 1834.
" "	Petersburg	1834	" " "	" "
" "	Gaston	1836	C. Tayleur & Co., Warrington	" 1836.
" "	Raleigh	1836	" " "	" "
" "	Roanoke	1837	Edward Bury, Liverpool	" 1837.
" "	Virginia	1837	Benjamin Hick, Bolton	" "
Wilmington & Raleigh	Wayne	1837	Robert Stephenson	14 months.
" "	Nash	1837	" "	14 "
" "	Halifax	1838	D. & I. Burr & Co.*	3 "
" "	Sampson	1838	" " "	1 month.
South Carolina	Georgia	1834	Edward Bury, Liverpool	Half the time.
" "	Augusta	1834	" " "	" " "
" "	William Aiken	1834	Stephenson & Co., Liverpool	One-fourth the time.
" "	E. Houy	1834	" " "	One-fifth " "
" "	H. Schultz	1835	Rothwell, Bolton	" " "
" "	Sumter	1835	Stephenson & Co., Liverpool	One-third " "
" "	Marion	1835	" " "	" " "
" "	Ohio	1835	" " "	" " "
" "	Cincinnati	1835	Tayleur, Liverpool	One-fifth " "
" "	Allen	1835	" "	One-fourth " "
" "	Kentucky	1835	" "	One-fifth " "
" "	Tennessee	1836	Rothwell, England	One-sixth " "
Ponchartrain	Ponchartrain	1832	Rothwell, Hick & Rothwell	5 years.
"	Creole	1833	Edward Bury	4 "
"	Fulton	1834	Benjamin Hick & Son	3 "
"	Orleans	1836	Edward Bury	2 "
Carrollton	New Orleans	1837	Benjamin Hick & Co	3 months.
Lexington & Ohio	Nottoway	1836	John Bull (?)	2 years.
" "	Elkhorn	1836	" "	2 "

* It is not certain whether these were English or American builders.

form, the diffused phosphorescence giving place to luminous streaks. It would seem, therefore, that after a certain degree of rarefaction has been attained the gaseous molecules are no longer sufficient in number to act as carriers for an ordinary charge, while a more powerful one bridges the space only by the aid of the few that remain. The result almost justifies the presumption that ponderable matter is always necessary for the passage of electricity through space, but at the same time it opens up the question whether space can ever be wholly free of ponderable matter. If a certain amount of vapor be still given off by mercury at 140° below its freezing-point, to what temperature below *minus* 274° must we suppose hydrogen to be cooled in order to insure that no residuum shall remain in the gaseous form ?

Professor Dewar carried out a very simple but very striking experiment which forcibly demonstrates the truth of the molecular theory. He took a high vacuum bulb containing only a minute quantity of mercurial vapor, to which was connected by a short neck of from one-tenth to one-eighth of an inch bore a smaller bulb containing liquid mercury. On applying liquid air to a portion of the larger bulb the contained vapor was at once condensed as a small mirror. On applying the liquid to a second portion of the glass no further condensation was obtained, thus proving that the metallic surface a couple of inches below could not supply vapor to replenish the larger bulb. But on inclining the apparatus so as to pass a globule of mercury into the larger bulb itself the cold spots on the glass were instantaneously covered with dense metallic depos-

its. Of the myriads of molecules projected in all directions from the liquid mercury in the smaller bulb only a small percentage—which might be determined by the theory of probabilities—struck the orifice of the neck in such a way as to shoot clean through into the larger bulb. Hence the loss from condensation could not be made good, although there was free communication with another chamber containing vapor at a relatively high pressure.

The lecturer showed the method of determining the tensile strength of metals at 180° below zero. Large quantities of liquid air are necessary, since the considerable mass of metal forming the jaws of the testing machine has to be completely immersed. The results are extremely interesting. The breaking strain is in all cases greatly increased, and in some—*e.g.*, iron and German silver—is nearly doubled. In the case of certain metals equally remarkable increase occurs in the percentage of elongation before rupture, though the results on this point require verification. Thus, while chemical forces are in abeyance at very low temperatures, the physical force, which we call cohesion, asserts itself with immensely increased power. This is of great importance in connection with theories which have been ably advocated in some quarters, according to which a sufficient reduction of temperature would reduce the universe to "cosmic dust." That material, so valuable to some speculators, will have in future to be obtained from some other source than the disintegration of matter by cold. Lord Kelvin maintains, on the other hand, that cohesion may be accounted for without assuming any other force than that of gravitation, or any other law than the Newtonian. Contraction of bulk without reduction of mass is the sole condition he requires for indefinite increase of cohesive force, and this is obviously the condition supplied by Professor Dewar's experiment, while the result is entirely concordant with Lord Kelvin's theory.

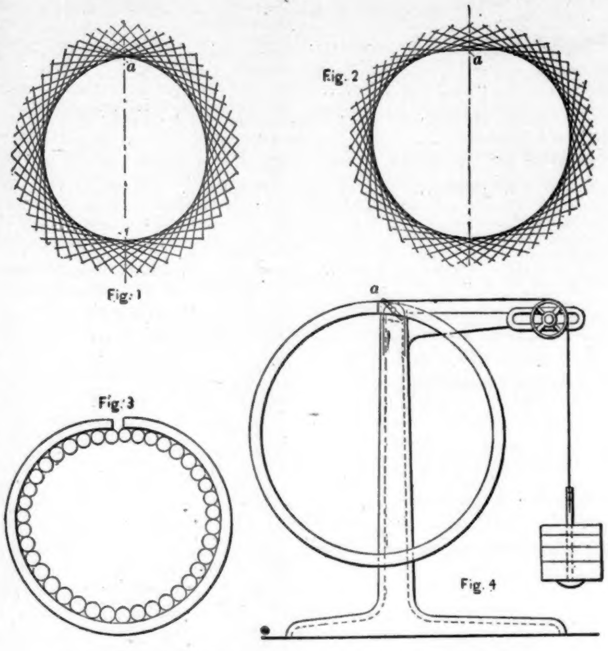
An American experimenter has found that a temperature of 80° below zero very greatly diminishes the power of a permanent magnet. But Professor Dewar has proved that this result follows only in the case of a super-saturated magnet. If a magnet be taken which has been passed through ordinary cycles of change, and therefore carries what may be called a normal charge of magnetism, its magnetic activity is markedly increased by reduction of temperature. This was shown by direct experiment, and the result was confirmed by coiling a wire round the magnet at ordinary temperature and immersing the end of the magnet in liquid air, when an electric current was instantly generated in the wire. An immense field of work lies before the physicist in connection with these experiments alike upon cohesion and upon magnetism. There are various theories which will have to take account as best they can of facts which cannot be questioned, however they may ultimately be explained. The increase of cohesion and magnetic force at very low temperatures must be taken in conjunction with the disappearance of electrical resistance in pure metals already worked out at the Royal Institution, and this, again, is complicated by the reverse effect obtained when the metals are contaminated by impurities of any kind.

Low temperature was shown to have a remarkable effect upon the color of many bodies. For example, the brilliant scarlet of vermilion and mercuric iodide is reduced under the influence of intense cold to a pale orange, the original color returning with the rise of the temperature. Blues, on the other hand, are unaffected by cold, and the effect is comparatively small upon organic coloring matters of all tints. This is of interest in connection with the efforts that have been made to find a chemical explanation of the color of salts, and, indeed, with the phenomena of isomorphism in general.

It may be judged from this imperfect sketch how numerous and far-reaching are the possibilities of the work now being done at the Royal Institution.—*London Times.*

DUNBAR'S PISTON-PACKING RINGS.

A NEW packing ring for pistons, and the scheme that was followed in its development, are illustrated herewith. It is a plain ring made in such shape that it will fit a cylinder and make the piston steam-tight with the least possible frictional resistance. Fig. 1 was made from a 16-in. ring after it had $\frac{3}{4}$ in. cut out, then springing it together, and holding it by a flexible band. It was then laid on drawing paper, and a line was drawn on its inner circumference. It was then removed, the line spaced off into inch spaces, and from the space points the lines were drawn that bound the figure, which shows the shape that a round ring will take, when about $\frac{3}{16}$ in. to the foot is cut out of it and then sprung together by an equal external radial pressure. Fig. 2 was made from a like ring cut in two with a very thin tool, sprung apart $\frac{3}{4}$ in. less the thickness of the tool, and held open by a number of short rounds, as shown in fig. 3. The line was then drawn on the outside of the ring, spaced, and the figure outlined, as in fig. 1. The rounds produce an equal internal radial pressure the opposite of fig. 1. Hence it follows that if a 16-in. ring is made the shape of fig. 2, then $\frac{3}{4}$ in. cut out and sprung together by an equal external radial pressure, the ring will be round. The cut in the rings is at *a*. The rings are cast close to size and



NEW METHOD OF FORMING PISTON RINGS.

shape, then ground to the exact size. Fig. 4 is a tester by which the tension and circularity of a ring may be determined. The ring is clamped in the vise at the top of the column, near one of its ends, a steel tape is secured to the end in the vise, the tape is passed around the ring and over the friction pulley on the arm, and weights applied to the end till the cut is closed, when its circularity may be tested.

PRICES OF NOVA SCOTIA COAL.

THE following report has been made by our Consul-General at Halifax, to the Bureau of Statistics, Department of State, at Washington, which will be interesting in view of the agitation growing out of the discussion of the Wilson bill.

In compliance with the request of the Department, I enclose a statement covering the cost of mining coal in Nova Scotia and of shipping it to the United States, prepared by Mr. M. R. Morrow, of Halifax, who is considered the highest authority:

Cape Breton coal,* at mines' ports, which are all within 25 miles of the respective mines—

	Per ton.
Screened	$2 50
Run of mine	1 80
Slack	1 10

These are subject to a discount of 5 cents per ton for 1,000 tons and over, 10 cents per ton for 5,000 tons and over, and 15 cents per ton for 10,000 tons and over.

Pictou coal, shipped at Pictou, about 15 miles from the mines—

	Per ton.
Screened Acadia	$2 50
Run-of-mine Acadia	2 25
Slack Acadia	1 50
Culm	80
Screened Drummond	2 25
Run-of-mine Drummond	2 00
Slack Drummond	1 50
Culm Drummond	80

* It is assumed that this is the price at mines' ports, although the report does not distinctly say so.

Pictou is closed to navigation for five months of the year, when the coal must be shipped from Halifax, 100 miles distant, at an additional cost over Pictou of 80 cents per ton.

Spring Hill coal, at Parrsborough, 27 miles distant from the mines—

	Per ton.
Screened	$2 75
Run of mine	2 50
Slack	1 40
Culm	1 00

The estimated cost in 1893 of mining and shipping the various coals of the province, free on board vessels at the mines' ports, for run-of-mine coal was:

	Per ton.
Cape Breton coal	$1 40
Pictou coal:	
Acadia mine	2 00
Drummond mine	1 85
Spring Hill coal	2 15

Prices paid miners at Cape Breton mines were as follows:

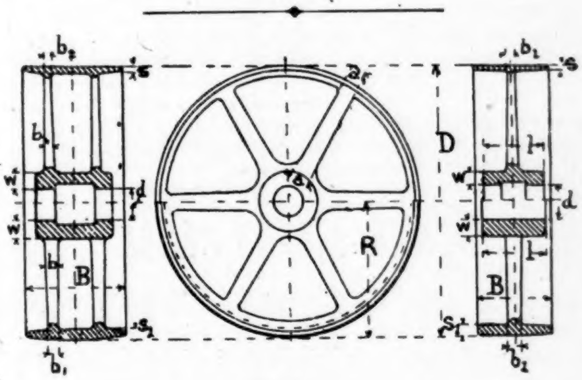
	Per ton.
Gowrie	$0 46
Little Glace Bay	42
International	44
Old Bridgeport	44
Reserve	42
Emery	43
Gardener	55

Coal freights from Nova Scotia to New England during the last five years averaged $1.90 per ton on the small quantity sent there, which was mostly in sailing-vessels.

The above prices and rates are for the ton of 2,240 lbs.

Darius H. Ingraham,
Consul-General.

Halifax, January 4, 1894.



DIMENSIONS OF CAST-IRON PULLEYS.

DIMENSIONS OF CAST-IRON PULLEYS (SINGLE ARMS).

Breadth from 4 in. to 6½ in.

D	No. of Arms.	a	a_1	b	b_1	s	s_1
in. in.							
8 to 12	4	1⅝	1 1/16	21/32	17/32	5/16	13/32
12¼ " 15¾	4	1 7/16	1 1/16	11/16	17/32	5/16	13/32
16¼ " 19¾	4	1½	1 3/32	¾	9/16	5/16	13/32
20 " 23½	4	1 9/16	1⅛	23/32	9/16	⅜ full	13/32
24 " 27½	4	1 21/32	1 3/16	13/16	19/32	⅜ full	⅜ full
24 " 27½	6	1½	1⅛	¾	9/16	⅜ full	13/32
28 " 31½	6	1 9/16	1⅛	25/32	9/16	⅜ full	⅜ full
32 " 35½	6	1 21/32	1 3/16	13/16	19/32	⅜ full	⅜ full
36 " 39½	6	1¾	1 3/16	⅞	19/32	⅜ full	⅜ full
40 " 43½	6	1 13/16	1¼	29/32	⅝	13/32	13/32
43¾ " 47¼	6	1⅞	1⅜	15/16	21/32	13/32	13/32
47½ " 51	6	1 31/32	1 13/32	1	23/32	13/32	13/32
51½ " 55	6	2	1¼	1 1/16	¾	15/32	15/32
55½ " 60	6	2⅛	1 9/16	1 1/16	25/32	15/32	15/32

$W = \frac{d}{6} + \frac{D}{100} + \frac{3}{8}$ in. $1 = d$ to $2.5d$. $r = 0.75a$ = radius of elliptical arm.

DIMENSIONS OF CAST-IRON PULLEYS (SINGLE ARMS).

Breadth from 6½ in. to 11 in.

D	No. of Arms.	a	a_1	b	b_1	s	s_1
in. in.							
8 to 12	4	1 9/16	1¼	21/32	⅝	13/32	⅜
12¼ " 15¾	4	1½	1⅜	⅞	11/16	13/32	⅜
16¼ " 19¾	4	1⅞	1 13/32	15/16	23/32	⅜	⅜
20 " 23½	6	1⅞	1 13/32	15/16	23/32	⅜	13/32
24 " 27½	6	1 31/32	1½	1	¾	⅜	13/32
28 " 31½	6	2⅛	1 19/32	1 1/16	25/32	⅜	13/32 full
32 " 35½	6	2 7/32	1 21/32	1 3/32	13/16	13/32	13/32 full
36 " 39½	6	2⅜	1¾	1 3/16	⅞	13/32	13/32
40 " 43½	6	2 7/16	1¾	1¼	⅞	13/32	15/32
43¾ " 47¼	6	2½	1 13/16	1¼ full	29/32	13/32	15/32
47½ " 51	6	2 19/32	1⅞	1 9/32	15/16	15/32	15/32
51½ " 55	6	2 11/16	1⅞	1 11/32	15/16	15/32	15/32
55½ " 61	6	2¾	1 31/32	1⅜	1	15/32	½
61¼ " 67	6	2 27/32	1 31/32	1 13/32	1	17/32	½
67½ " 72¾	6	2 29/32	2 1/16	1 7/16	1 1/32	17/32	9/16
67½ " 72¾	8	2 11/16	1 11/16	1 11/32	2 9/32	17/32	9/16
72¾ " 78¾	6	3	2⅛	1½	1 1/32	17/32	9/16
72¾ " 78¾	8	2¾	1¾	1⅝	15/16	17/32	9/16

$W = \frac{d}{6} + \frac{D}{100} + \frac{13}{32}$ in. $1 = 1.5d$ to $3.5d$. $r = 0.75a$ = radius of elliptical arm.

—*Mechanical World.*

ACCIDENTS TO LOCOMOTIVE ENGINEERS AND FIREMEN.

The object of publishing this monthly list of accidents to locomotive engineers and firemen is to make known the terrible sacrifice of life and limb that is constantly going on among this class of people, with the hope that such publication will in time indicate some of the causes of accidents of this kind, and help to lessen the awful amount of suffering due directly and indirectly to them. If any one will aid us with information which will help to make our list more complete or correct, or who will indicate the causes or the cures for any kind of accidents which occur, they will not only be doing us a favor, but will be aiding in accomplishing the object of publishing this report, which is to lessen the risk and danger to which the men to whom we all intrust our lives are exposed.

The only, or the chief source of information we have, from which our report is made up, is the newspapers. From these the following list of accidents, which occurred in January, has been made up. Of course we cannot report those of which we have no knowledge, and doubtless there are many such.

ACCIDENTS FOR JANUARY.

Pottsville, Pa., January 1.—A collision occurred on the Mahanoy Division of the Lehigh Valley Railroad, between Buck Mountain and Delano, this afternoon. A coal train pulling out from a siding from a colliery collided with a passenger train. Both engineers were badly hurt.

Little Rock, Ark., January 1.—A boiler of a freight train exploded near Beebe, on the Iron Mountain Road, this morning. John Dooley, the fireman, was severely injured. The engineer escaped with slight injuries.

East Weymouth, Mass., January 5.—An engine collided with a Middleborough train at this point to-day and was thrown from the track. The engineer, Mildram, was slightly injured, and Frank Williams, fireman of the wrecked train, was cut.

Parkville, N. Y., January 9.—Two work trains used in making repairs on the Long Island Railroad collided at this point this morning. Fireman Waren sustained a compound fracture of the leg.

Franklin Falls, N. H., January 11.—A boiler of a locomotive exploded at this point to-day, injuring the engineer, Ed. Bowler, very severely by breaking one leg and badly bruising his head. John Ballantyne, the fireman, was badly scalded.

Meadville, Pa., January 11.—A wreck on the Pittsburgh, Shenango & Lake Erie Railroad occurred to-day. Fireman Porter was very severely injured, and it is feared he might die from his injuries. Engineer Unger was seriously hurt, and at the time of this dispatch the chances are against his recovery.

Easton, Pa., January 13.—A fast freight on the Lehigh Valley Railroad ran into the rear of a preceding section on a high embankment where the road enters the town of Phillipsburg, N. J. The engineer and fireman remained on the engine until it stopped. Engineer Hanlan had his arm broken.

Pittsfield, Me., January 13.—An engine on the Canadian Pacific Railroad jumped the rails near Jackman to-day, careen-

LOCOMOTIVE RETURNS FOR THE MONTH OF NOVEMBER, 1893.

Name of Road.	Number of Serviceable Locomotives on Road.	Number of Locomotives Actually in Service.	Locomotive Mileage.					Av. Train.		Coal Burned per Mile.						Cost per Locomotive Mile.							Cost per Car Mile.		Cost of Coal per Ton.
			Passenger Trains.	Freight Trains.	Service and Switching.	Total.	Average per Engine.	Passenger Cars.	Freight Cars.	Passenger Train Mile.	Freight Train Mile.	Service and Switching Mile.	Train Mile, all Service.	Passenger Car Mile.	Freight Car Mile.	Repairs.	Fuel.	Oil, Tallow and Waste.	Other Accounts.	Engineers and Firemen.	Wiping, etc.	Total.	Passenger.	Freight.	
										Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	$
Atchison, Topeka & Santa Fé	822	744	....	....	....	2,235,110	3,004	....	....	....	....	....	90.54	....	....	4.53	7.72	0.22	0.14	6.81	1.25	20.67	....	....	1.64
Canadian Pacific	613	582	475,790	759,420	415,080	1,650.290	2,835	....	....	....	....	....	73.29	....	....	3.99	11.72	0.35	....	5.78	1.39	23.23	....	....	3.20
Chic., Burlington & Quincy	542	....	....	....	....	1,485,812	2,741	5.34	19.24	....	....	....	90.17	....	....	3.80	6.49	0.22	0.27	6.61	0.06	17.45	....	....	1.43
Chic., Milwaukee & St. Paul	856	....	....	....	....	2,700,877	3,155	....	....	....	....	....	79.27	....	....	3.83	8.02	0.27	....	6.78	....	18.90	....	....	2.38
Chic., Rock Island & Pacific	....	....	503,205	1,013,431	341,535	1,858,171	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Chicago & Northwestern	1010	....	814;064	1,449,375	645,274	2,908,713	2,879	....	....	....	....	....	94.56	....	....	3.58	8.54	0.30	....	6.37	0.76	19.55	....	....	1.79
Cincinnati Southern	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Cumberland & Penn.*	23	23	5,186	37,747	....	42,933	1,866	....	....	....	....	....	90.74	....	....	8.14	4.53	0.36	....	....	1.63	14.66	....	....	....
Delaware, Lackawanna & W. Main L.	211	194	....	....	....	677,100	3,490	....	....	....	....	....	99.15	....	....	2.69	7.50	0.39	....	6.01	....	16.59	....	....	....
Morris & Essex Division	163*	....	178,040	153,037	95,755	426,832	2,618	....	....	....	....	....	68.56	....	....	3.65	10.69	0.35	....	6.48	....	21.17	....	....	3.08
Hannibal & St. Joseph	69	69	....	....	....	240,027	3,582	5.13	17.60	....	....	....	87.22	13.71	6.43	2.31	6.86	0.13	0.40	6.99	0.02	16.71	....	....	1.58
Kansas City, F. S. & Memphis	148	....	92,432	220,053	98,693	411,178	2,816	....	....	....	....	....	71.81	....	....	3.03	6.08	0.23	0.40	7.33	....	17.07	....	....	1.65
Kan. City, Mem. & Birm	42	40	34,970	62,675	15,134	112,679	2,817	....	....	....	....	....	69.01	....	....	2.93	3.94	0.25	0.33	6.87	....	14.32	....	....	1.10
Kan. City, St. Jo. & Council Bluffs	37	37	50,108	41,515	37,138	128,761	3,480	5.71	22.00	....	....	....	73.77	14.63	4.98	2.87	8.27	0.16	0.46	6.28	0.04	18.08	....	....	2.34
Lake Shore & Mich. Southern	594	....	428,499	809,463	443,458	1,681,420	3,057	....	....	68.79	96.61	22.12	74.54	....	....	2.27	5.78	0.07	0.11	6.90	0.18	15.31	....	....	1.54
Louisville & Nashville	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Manhattan Elevated	291	....	743,978	....	65,426	809,404	2,781	....	....	....	....	....	43.19	....	....	2.60	8.50	0.20	....	9.20	....	20.50	....	....	3.92
Mexican Central	148	122	....	....	....	394,374	3,232	....	....	....	....	....	71.55	....	....	5.51	14.03	0.43	0.21	4.69	0.68	25.55	....	....	4.34
Minn., St. Paul & Sault Ste. Marie	103	90	83,413	128,825	54,618	266,856	2,965	4.94	21.45	....	....	....	76.10	....	5.17	4.52	13.78	0.26	....	6.65	....	25.21	4.19	1.32	3.61
Missouri Pacific	346	....	....	....	....	1,013,282	3,375	4.41	17.58	....	....	....	90.09	....	....	5.00	6.34	0.34	1.20	6.37	1.44	20.69	4.06	1.43	1.39
Mobile & Ohio	107	85	74,166	166,477	58,328	298,971	3,517	....	....	....	....	....	68.08	....	....	2.64	4.88	0.22	0.59	5.32	0.85	14.50	....	....	1.43
N. O. and Northeastern	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
N. Y., Lake Erie & Western	638	410	440,475	871,459	260,385	1,572,319	3,835	4.70	23.90	92.50	145.20	94.50	110.73	19.60	6.10	4.78	8.14	0.37	2.01	7.43	1.15	23.88	....	....	1.37
N. Y., N. H. & H., Old Colony Div	....	....	401,240	143,825	184,530	729,595	....	4.00	16.40	....	....	....	63.66	16.50	5.50	3.33	9.54	0.62	....	7.06	0 87	21.42	....	....	....
N. Y., Pennsylvania & Ohio	273	181	135,595	421,762	128,633	685,990	3,513	5.60	17.50	111.70	132.20	77.75	108.22	20.40	7.50	4.68	6.73	0.31	1.70	6.91	1.00	21.33	....	....	1.12
Norfolk & Western, Gen. East. Div.†	....	....	90,360	291,602	44,278	436,240	2,644	5.50	20.70	54.08	129.74	....	91.91	9.90	6.30	5.50	4.11	0.28	....	....	....	9.89	....	....	3.60
General Western Division†	....	....	97,040	305,996	51,034	454,070	2,793	5.63	16.02	89.60	133.00	....	111.00	15.80	8.28	6.07	4.61	0.26	....	....	....	10.94	....	....	....
Ohio and Mississippi	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Philadelphia & Reading	....	....	420,908	306,623	....	1,703,228	....	....	....	....	....	....	80.45	....	....	4.09	4.92	0.34	....	5.85	0.42	15.62	....	....	....
Southern Pacific, Pacific System	737	665	618,662	850,268	264,341	1,733,271	2,352	5.50	14.27	....	....	....	69.35	....	....	4.49	16.93	0.20	2.23	7.33	1.14	32.32	....	....	....
Union Pacific	989	989	527,047	1,422,488	408,578	2,358,113	3,483	6.49	17.74	....	....	....	110.25	....	....	6.82	10.57	0.39	....	8.04	1.08	26.90	3.89	1.90	1.91
Wabash	425	355	426,166	614,491	228,946	1,269.603	3,574	4.86	17.14	71.53	111.22	60.59	90.09	14.70	6.48	3.58	5.18	0.28	....	6.19	0.90	16.13	2.94	1.08	1.19
Wisconsin Central	149	106	114,399	163,978	46,132	324,509	3,061	....	....	....	....	....	84.21	....	....	3.31	9.63	0.20	....	7.19	....	20.33	....	....	2.27

NOTE.—In giving average mileage, coal burned per mile and cost per mile for freight cars, all calculations are made on the basis of *loaded* cars. Empty cars which are reckoned as one loaded car are not given upon all of the official reports, from which the above table is compiled. The Union and Southern Pacific, and New York, New Haven & Hartford rate two empties as one loaded; the Kansas City, St. Joseph & Council Bluffs and Hannibal & St. Joseph Railroads rate three empties as two loaded; and the Missouri Pacific and the Wabash Railroads rate five empties as three loaded, so the average may be taken as practically two empties to one loaded.

* Switching engines allowed 6 miles per hour; wood, construction and gravel trains, 10 miles per hour.

† Wages of engineers and firemen not included in cost.

ing and tipping over. Engineer William Hunting had both legs so badly broken that it is thought he cannot recover.

Pittsfield, Me., January 13.—A mogul engine with a snow-plow ahead, on the Canadian Pacific Railroad, while engaged in clearing the track encountered a deep drift near Harvey Lake, in which the engine jumped the track and went out upon the ice upon the lake. The engineer escaped through the cab window, but as the locomotive went down the fireman was pinned in and was drowned in 28 ft. of water.

Statesville, N. C., January 13.—An engine of a passenger train on the Murphy Division Branch of the Western North Carolina Road jumped the track near Nantahala to-night, rolled down an embankment, and the engineer was severely scalded.

Winchester, Ind., January 13.—An engine pulling a freight train exploded its boiler on the Big Four track in front of this station to-day, while the train was running at the rate of about 10 miles an hour. Both ends of the boiler and the bottom were blown out. Albert Rankin, the fireman on the engine, was scalded to death. Lafe Mullen, the engineer, escaped with slight injuries.

Halifax, N. S., January 14.—A snow-plow and engine on the Windsor & Annapolis Railway broke through a bridge between Middletown & Wilmot to-day. Engineer Pudsey and Fireman Frank Smith were instantly killed.

Harrison, N. J., January 15.—While the Dover Express on the Delaware, Lackawanna & Western Railroad was approaching the draw-bridge over the Hackensack River this morning, it ran into a preceding train at a speed of 20 miles an hour, crushing into the rear and telescoping four cars. David Hoffman, the engineer, was seriously injured and carried into the baggage car in an unconscious condition. His legs and head were cut and bruised, and he is supposed to be internally injured. The fireman was slightly injured.

Santa Rosa, Cal., January 15.—An accident occurred on the narrow-gauge road at the Austin River bridge to-day. A locomotive was detached from the train to reconnoiter for washouts. It crossed the bridge in safety, but in returning, the piling having been undermined, the engine crashed through. Engineer Briggs and Fireman Colliston were drowned.

Montreal, Can., January 15.—Edgar Vary, a fireman on the Grand Trunk train, was underneath his engine to day, when another train came up with the object of coupling some cars. The contact was made too suddenly, and Vary was injured about the hips.

Syracuse, N. Y., January 16.—George Gilwater, a fireman on the New York Central & Hudson River Railroad, was struck on the head by a mail crane while leaning out of the cab this morning. He was rendered unconscious, but suffered no serious injury.

South Shaftesbury, Vt., January 16.—A passenger train on the Bennington & Rutland Road collided with a wrecking train about a mile from this station this morning. Engineer William Smith died from injuries which he received.

Weston, W. Va., January 19.—A wreck occurred in the mountains of Randolph County to day. McQuay's log engine with a train loaded with logs ran away down the mountain, badly injuring E. M. Shives, engineer.

St. Louis, Mo., January 20.—A Wabash engine jumped the track and ran into the Mississippi River at East St. Louis to-day. George Kirby, the engineer, was drowned.

Montgomery, Ala., January 21.—A train on the Central Railway of Georgia ran into a cow near Fitzpatrick to-night and was thrown from the track. Engineer Williams and Fireman Kimball were badly scalded.

Fort Worth, Tex., January 22.—Engineer Bethel, of the Rock Island Road, while engaged in oiling his engine at Chicasha this evening, was struck on the head and severely injured.

Cedar Rapids, Ia., January 23.—A Burlington, Cedar Rapids & Northern train was wrecked near Potsville this evening by a broken rail. The engine and four cars were overturned. Engineer Tencill Sheffrenik was caught under the tank and killed.

Springfield, Ill., January 28.—A wreck occurred on the St. Louis, Chicago & St. Paul Railroad about 3 miles south of Curren this evening, which resulted in the death of Engineer William Deadman, of Alton.

Como, O., January 29.—A rotary snow-plow pushed by two engines on the Union Pacific Line ran into a broken rail near this point to-day, and the plow and one of the engines ran off the embankment, rolling over three times and landing 150 ft. from the track. Engineer Snow and Fireman Calihar received severe injuries.

Columbia, Pa., January 29.—A broken axle on an east-bound freight train on the Philadelphia Division, Pennsylvania Railroad, was the cause of a bad crash near Docklow to-day. Fireman John Rupert was injured by being caught between falling timbers as he jumped from the engine.

Millerton, Pa., January 30.—A train on the Tioga Railroad was stuck in a snow drift 5 ft. deep here this evening. The snow packed so hard against the cab on the fireman's side that it was forced in. George Case, the fireman, was dragged from the cab, but not until he had been suffocated to death in the snow.

Rochester, N. Y., January 30.—An east-bound passenger train on the New York Central & Hudson River Railroad, while taking a side track at Albion this evening, ran into an open switch. Engineer Osborn E. Chamberlain tried to jump, but his left leg was caught between the engine and tender. When released an hour later it was found that both bones were broken at the knee and ankle; he also complained of other injuries. Fireman Brooker was thrown through the cab window, striking his head on a pile of stones. A deep gash was cut across the forehead, and his nose was broken and right leg injured.

St. Paul, Minn., January 31.—An engine pulling a passenger train on the St. Paul & Duluth Railroad broke a side-rod about 2 miles west of Barnum this afternoon. It damaged the cab and broke a small cock on the boiler, allowing the steam and water to escape. Hank Gage, the engineer, was scalded, also his fireman.

Our report for January, it will be seen, includes 27 accidents, in which five engineers and five firemen were killed, and 16 engineers and 13 firemen were injured. The causes of the accidents may be classified as follows:

Boiler explosions	4
Broken axle	1
Broken rails	2
Broken side-rod	1
Cattle on track	1
Collisions	5
Defective bridges	2
Derailments	3
Misplaced switch	1
Runaway engine	1
Run over	1
Suffocated by snow	1
Struck by obstruction	1
Unknown	3
	27

PERFORMANCE OF A COMPOUND LOCOMOTIVE ON THE LONG ISLAND RAILROAD.

The following statement gives particulars of the performance and economy of compound locomotive No. 145, in comparison with single-expansion locomotive No. 138, built by the Baldwin Locomotive Works for the Long Island Railroad Company.

The engines set apart for the test by Mr. Prince, Superintendent of Motive Power, were compound engine No. 145 and simple engine No. 138. These engines were built by Burnham, Williams & Co., 1893, and are precisely similar, except for the compounding of No. 145 on the Vauclain four-cylinder type. They had both been in the shops for general repairs at a late date, and were put on this service as being both in equally good running condition.

For the purpose of this test:

1. A train of 20 loaded cars was set apart for the haul.
2. The section of track between Hempstead Crossing and Ronkonkoma was used; and the train hauled the round trip twice each day, making a total daily run of 113.78 miles.
3. Two cars of Clearfield coal were set apart by the storekeeper as being from the same mine, and were used exclusively on the series of tests.
4. It was decided to run the test train three days with one engine, and then three days with the other, making a series of tests of three days with each.
5. All coal was weighed on and off, from point of start to return to that point, and the water consumption was measured with Thompson patent water meters attached to the injector or suction pipes.

It will be seen that with the same train over the same course the work on each day was the same. On the first three days the compound engine was used; on the second three days the simple engine. On the first day's run with each engine the flue tubes and grates and front end were all perfectly clean, and on all succeeding days all conditions were similar, and the engines were in simple running order. Each day's run for consumption was reckoned only from the time of starting with

the train, and each day was concluded exactly at the point of origin, the fires being brought up to level as at starting, and the water in boiler being brought exactly up to the level of top cock, the same engineer and fireman being retained for the whole series.

All weather conditions were adverse to the compound engine; as one day (November 4) was exceedingly wet, and on the succeeding day the coal was still soaking from the previous one. The resultant economy, it will be seen, is figured up as 37.2 per cent. in coal and 17.2 per cent. in water on the simple basis of *per car per mile*; but making allowance for the increased length of terminal stoppages with the simple engine, I have also entered up the economy per car per mile *per hour* as 32.1 per cent. in coal and 10.7 per cent. in water, each in favor of the compound engine.

the crown of the arch, and about 33 ft. wide. The total cost of the work will be $1,700,000.

Conversion of a Steam into an Electric Road.—The Brooklyn, Bath & West End Railroad, which runs from Greenwood Cemetery to Coney Island, and which was originally built as a dummy road, and operated for the last few years as a steam road doing a heavy traffic, especially in the summer time, between Coney Island and Bath Beach and Brooklyn, has been changed into an electric road. This is the first instance in New York State in which the substitution of electricity for steam power has been effected. People living along the line of the road are very much pleased with the change, and in a future issue we hope to give some data regarding the actual operation of the road.

COMPARATIVE TESTS OF FUEL AND EVAPORATION ON COMPOUND ENGINE NO. 145 (VAUCLAIN TYPE) AND STANDARD ENGINE NO. 138.

	Engine No. 145.				Engine No. 138.			
Engine Dimensions.								
Cylinders, diameters, and stroke	12" and 20" x 24"				18" x 24".			
Diameters of driving-wheels and No	3 pairs = 60$\frac{9}{16}$" diameter.				3 pairs = 60$\frac{9}{16}$" diameter.			
Type of engine	Baldwin Ten-wheeler.				Baldwin Ten-wheeler.			
Boiler, diameter and length	Barrel = 54 : wagon top, 57⅛ and 60¼ x 140½.				Barrel = 54"; wagon top, 57⅛ and 60¼ x 140½.			
Boiler grate, dimensions	22¼ sq. ft.				22¼ sq. ft.			
Boiler tubes, No. and sizes and surface	200 x 2¼ x 140½ x 1,216¾ sq. ft.				200 x 2¼ x 140½ x 1,216¾ sq. ft.			
Boiler, total heating surface	1,342¾ sq. ft.				1,342¾ sq. ft.			
Exhaust nozzle, diameter	3½".				3½".			
Weight of engine, (1) on drivers, (2) gross					(1) 78,700, (2) 106,150, and tender = 173,150.			
	1st day, Nov. 3.	2d day, Nov. 4.	3d day, Nov. 5.	Average.	1st day, Nov. 6.	2d day, Nov. 7.	3d day, Nov. 8.	Average.
Conditions of Tests.								
Coal used on all days	Moshannon Clearfield coal. Same cars used.							
Weather	Fair, no rain	Rain.	Fair.		Perfect.	Perfect.	Fair.	
Condition of engine and fires	Clean fires and tubes and front end swept.	Ordinary working conditions.	Ordinary working conditions.		Clean fires and tubes and front end swept	Ordinary working conditions.	Ordinary working conditions.	
Train hauled. No. of cars	20	20	20	20	20	20	20	20
Train hauled. Gross weight, net tons	819	819	819	819	819	819	819	819
Train hauled. Tare weight, net tons	255	255	255	255	255	254	254	254
Train hauled. Net weight, net tons	564	564	564	564	564	565	565	565
Mileage. Course	Hempstead Crossing and Ronkonkoma and return—twice daily.							
Mileage. Total daily mileage with train	113.78	113.78	113.78	113.78	113.78	113.78	113.78	113.78
Test Figures.								
Coal consumed, in lbs	5,687	6,303	6,607	6,199	9,502	9,835	10,289	9,875
Water evaporated, in lbs	43,104	45,591	47,457	45,384	52,820	Right hand water meter failed, and no correct water readings obtained.	57,101	54,961
Evaporation, lbs. water per lb. coal	7.57	7.23	7.18	7.32	5.55		5.55	5.55
Running time	4° 18½′	4° 07′	4° 06′	4° 11′	4° 19½′	4° 32′	4° 32′	4° 28′
Stoppages	1° 14½′	1° 10′	1° 02′	1° 09′	1° 08½′	1° 26′	1° 19′	1° 18′
No. of stops other than terminal	1	2	nil.	....	1	1	nil.	
Total time with train	5° 33′	5° 17′	5° 08′	5° 19′	5° 28′	5° 58′	5° 51′	5° 45′
Total time engine using steam	3° 47′	3° 46′	3° 46′	3° 46′	3° 55′	3° 52′	3° 29′	3° 48′
Total time safety-valves blowing off	17′ 25″	20′ 30″	5′ 05″	14′ 20″	24′ 45″	4′ 45″	1′ 10″	10′ 13″
Injector feeding regularly. No. of applications	7	10	15	10⅔	10	13	15	12⅔
Average steam-pressure	169.5	170.25	160.4	166.7	130.1	123.9	124	126
Safety-valve set to blow off at — lbs	180	180	180	180	145	145	145	145
Results.								
Pounds of coal burned per train mile	54.4				86.8			
Pounds of coal burned per car mile	2.72				4.34			
Pounds of coal burned per ton, mile per hour of total time	0.01254				0.01847			
Average economy on ton, mile per hour of total time	32.1 per cent.							
Average economy in water per ton, mile per hour of total time	10.7 per cent.							
Average economy per car mile	Fuel, 37$\frac{2}{10}$; water, 17$\frac{2}{10}$.							

Sparks drawn from front end of Compound about ⅛ that from Standard engine.

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NOTES AND NEWS.

Timber Tests.—An elaborate series of timber tests are now in progress in the Testing Laboratory of the Washington University, under the Forestry Division of the Department of Agriculture.

Susquehanna Tunnel.—The tunnel under the Palisades for the New York, Susquehanna & Western is nearly finished, and before many months trains will be running through it. The last heading of the tunnel was broken through on January 11. The tunnel, which is reached by a branch from the main track back of Fairview, N. J., is 5,070 ft. long, 27 ft. high to

Trial of Armor Plate.—Another successful test of armor plate was made by the Bethlehem Iron Company on February 3. This test involved the acceptance of nearly 400 tons of armor, and the Government will take the plates. These are for the protected cruiser *Puritan*, now being built at Brooklyn. The plate is not Harveyized, and is 18 ft. long, 6 ft. wide and 14 in. thick, tapering to 6 in. in thickness. A 10-in. gun was used with projectiles weighing 500 lbs. each. The first shot penetrated the plate to the depth of 12½ in. There were no radiating cracks, and an even fringe about the hole 4 in. high. The projectile was broken in two. The velocity of the projectile was 1,381 ft. per second. The charge was 132 lbs. of powder. In the second shot 171 lbs. of powder sent the 500-lb. projectile through the air at a velocity of

1,630 ft. per second. The projectile penetrated to the depth of 15⅝ in., but the backing was not disturbed.

The Hungarian Zone System.—It is five years since the Hungarian Government decided to apply the "zone" system to its railways. Taking Budapest as the central point, a circle with 15 miles radius was drawn about it; beyond that another circle was described with 24 miles radius, and so on up to 11 circles. The twelfth and thirteenth circles each included a "zone" of 15 miles, and all the rest of the country made the fourteenth "zone." At the same time fares were reduced, on an average, 50 per cent. A person wishing to go anywhere within the first zone, 15 miles from Budapest or less, pays 20 cents first-class, 16 cents second, and 10 cents third. This rate is doubled for the second zone, anywhere within 24 miles, tripled for the third, and so on to the end. The result is now published. It shows an increase of passengers, upon the whole, to the amount of 216 per cent., and of receipts to the amount of 40 per cent. These returns exceed the most sanguine expectations.

Air Power for Street Cars.—Paris is shortly to try a new experiment with tramways worked by compressed air. There are already electric tramways running from the Madeleine to St. Denis and Pantin with accumulators under the carriage. These are reported to work very satisfactorily and are much more sightly than those of the "trolley" system in use in some of the French departments The new compressed-air machines, which are to be started from the Louvre to Versailles and St. Cloud, are expected to be more satisfactory than either as well as more economical in their working. The locomotives will weigh 18 tons and have a pressure of about 150 lbs., and be capable of drawing three or four cars loaded with passengers. The water of the Seine has been utilized as motive power for the compression of the air. The advantages expected are, besides economical working, the absence of smoke or odor from the machines, and they also, it is said, offer better facilities for dispatching several car loads of passengers at the same time by the same machine.—*Transport.*

Pneumatic Tubes in Chicago.—Pneumatic tubes have recently been laid in the streets of Chicago for connecting the City Hall and the Central Police stations with the office of the City Press Association, the various national and international news associations, and the main stations of the telegraph companies. It is stated that the time of transmission of messages from the points most distinctly separated is but one minute. Circulating in all of the tubes of the system is a continuous current of air, and when it is desired to transmit a package from one station to another, it is merely necessary to place the matter to be delivered in a carrier, which is inserted within the tube and it is instantly off. This is similar, as far as the operation is concerned, to that which is used by the Post Office Department in the city of London, but we have not as yet the information regarding details of the mechanism, so that we can give an accurate technical description of the various valves and appliances which are used. The pipes are laid in a trench in the street at sufficient depth, to get as far as practicable below all pipes and other obstructions. Twenty-nine conduits in a nest are then built of square vitrified clay pipes, into which seamless drawn brass pneumatic tubes are placed. The conduits are laid in and surrounded by Portland cement concrete from 8 to 10 in. thick, thus making it a solid wall of masonry which will not be affected by dampness, heavy traffic, or other causes. The motive power is said to be a jet of steam discharging through an injector. The air is expelled from the tubes, so that when the carrier is placed in position it is forced to its destination by atmospheric pressure. The carrier used is a new device. It is made of flexible leather with an inner wire frame to keep it in proper form, and to allow it to travel around the curves readily. These carriers are 2¼ in. in diameter and about 8 in. long.

Bertrand Rustless Process.—According to an account read before one of the French scientific societies, the Bertrand process of coating with magnetic oxide and enameling iron and iron carburets is much simpler than the better known Bower-Barff process, and is based upon a new discovery in chemistry. It is stated thus: If a thin adherent film of another metal is formed on the wrought iron or on the cast iron, and this iron or cast iron, heated to 1,000°, is exposed to a current of oxidizing gas, the oxygen penetrates through the film, oxidizes the iron or the cast iron, and under these conditions magnetic oxide is the result. The formation of magnetic oxide, thus obtained, continues indefinitely, and the thickness of the coating of oxide increases according to the period of exposure to the oxidizing current, providing the temperature remains at about 1,000°. None of the accounts seen in this country state whether this temperature is by the Centigrade or the Fahrenheit scale.

As to the film of metal deposited in the first instance, it disappears in some obscure way, forming oxides which mingle with the magnetic oxide or volatilize, according to the nature of the metal of which they are composed. M. Bertrand had then to find the best metal and the best method for depositing it on the article to be coated, and he has found that bronze, a mixture of copper and tin, gives from a practical point of view every satisfaction. For depositing this bronze on the wrought iron and cast iron M. Bertrand uses electricity or wet baths, and uses sulphophenolic acid.

The following is the method adopted in the Bertrand manufactory for an oxidation: The article is cleansed (the cleansing is not indispensable), then dipped a few moments in a bath containing a solution of sulphophenolate of copper and tin. The coating of bronze being formed, the article is immediately washed with cold water and dried with sawdust. The article dried is put into a furnace. Oxide forms, and at the end of 15 to 30 minutes (according to the articles) the article is taken out sufficiently oxidized. The coating produced varies from four to eight-thousandths of an inch in thickness.

M. Bertrand uses electricity to ascertain if the coating is of sufficient and uniform thickness, and in doing so he makes use of bells. If in putting the two wires in contact with the oxidized article the bells ring, the current passes—the oxidation is insufficient; if it remains silent, the oxide formed is of sufficient practical thickness, because it prevents the electric current from passing. To obtain tinning on iron, salts of tin are dissolved in a mixture of water and sulphophenolic acid at the rate of 1 per cent. of tin salt and 5 per cent. of sulphophenolic acid. In this mixture the article, which is previously cleaned, is dipped, and is at once covered with an adherent coating of tin, and afterward by the means of rotating brushes in wire and cloth the coating of tin is polished, and a result is obtained which is both effective and cheap.

For enameling iron the direct process is stated to be dangerous to the operator, and impossible in the case of large articles. In the Bertrand enameling, the article is first coated with magnetic oxide, then dipped in borosilicates of lead, colored by metallic oxides, in which is added a little pipe clay in order to give rather more body. The article thus covered cold, by dipping or with brushes, is put into the furnace; the enamel adheres and vitrifies at the usual furnace temperatures used by enamelers. By putting a coating of colored enamel with a brush on a first coat simply plain, it is possible to make any decorations desired, which may be burned in at one operation for out-door vases, etc. These results, due to the first oxidation with magnetic oxide, are remarkable as much for the color as for the tenacity of the enamel and its resistance to rough usage.

PROCEEDINGS OF SOCIETIES.

Liverpool Engineering Society.—At a meeting on January 17 A. B. Holmes read a paper on the Public Supply of Electrical Energy; its cost and price. In Liverpool the cost increase in lamps since 1890 has been from 12,000 to 25,000. The load on a station supplying electricity for lighting purposes was shown to be extremely variable, the maximum load in winter being one hundred times greater than the minimum load in summer, the cost of working the plant being much greater in consequence than would be the case were it possible to run the plant under uniform load. It was pointed out that great advantage would be derived from any practicable method of storage, but that the high cost of accumulators at present prevents their commercial use for that purpose. Various methods of charging for the supply of energy were described and compared. It was stated that at the price charged for electricity in Liverpool the cost of lighting by incandescent lamps is approximately double that of gas. It was pointed out that the patents for incandescent lamps having expired, lamps will gradually be improved in efficiency, and that with reduced cost of production it is to be expected that the cost of electric light may in the future not exceed the present price of gas.

DETENTIONS TO TRAINS FROM FAILURES OF PASSENGER LOCOMOTIVES.

The following Table I gives a report of detentions to passenger trains on a prominent road from defects of locomotives for the month of January, 1894. It will repay careful study.

Table II gives the detentions on the same road for the same period for other causes than engine failures. These are enumerated in the first column. We will be glad to receive similar reports from other roads for purposes of comparison.

TABLE I.

STATEMENT OF DETENTIONS TO PASSENGER TRAINS FOR JANUARY, 1894.

CAUSE OF DETENTIONS.	A.		B.		C.		D.		Total	
	No.	Time.	No.	Time.	No.	Time.	No.	Time.	No.	Time.
		Min.		Min.		Min.		Min.		Min.
Air pump	2	0	1	10	..	..	1	10	4	20
Bricks	..	..	1	6	..	..	..	..	1	6
Blower disconnected	..	..	1	28	..	..	..	..	1	28
Cock on main drum	1	7	..	..	..	..	..	..	1	7
Driver broke	..	..	..	..	1	18	..	..	1	18
Equalizer broke	..	..	..	..	..	..	1	0	1	0
Engine leaking	..	..	..	..	..	..	1	5	1	5
Eccentric broke	..	..	..	..	..	..	1	85	1	85
Grates	1	6	..	..	..	..	1	7	2	13
Guide bolt	..	..	1	6	..	..	..	..	1	6
Governor pipe on air pump	..	..	1	4	..	..	..	..	1	4
Hose on feed pipe	..	..	..	..	..	..	1	20	1	20
Hose between engine and tender	..	..	..	..	..	..	1	5	1	5
Hot engine truck	1	0	..	..	1	40	1	15	3	55
Hot driving box	..	..	6	113	6	124	7	109	19	346
Hot tender truck	2	23	3	31	6	90	..	..	11	144
Injectors	..	..	1	0	1	55	.	..	2	55
Key in cross-head	..	..	1	45	..	..	..	..	1	45
Key in draw-head	..	..	..	..	..	..	1	57	1	57
Packing	1	0	1	8	..	..	..	..	2	8
Pop valve	..	..	..	..	1	17	..	..	1	17
Reach-rod	..	..	1	5	..	..	..	..	1	5
Stirrup in driving springs	..	..	1	25	..	..	..	..	1	25
Spindle on main-rod	..	..	..	..	..	..	1	45	1	45
Strap on main-rod and both cylinder-heads	..	..	..	..	..	..	1	108	1	108
Steam hose	..	..	..	..	1	25	..	..	1	25
Slide in front end	..	.	..	..	..	..	1	5	1	5
Steam-chest burst	1	46	1	35	..	..	..	..	2	81
Spring hanger	2	20	2	0	..	..	..	..	4	20
Train line pipe	..	..	1	13	..	..	..	..	1	13
Valves broke	..	..	1	10	..	..	..	..	1	10
Valve stem and yoke	.	..	..	..	1	0	1	47	2	47
Water bars	..	..	..	..	..	..	1	5	1	5
Wedge	..	..	1	2	..	..	..	..	1	2
Waste on fire	..	..	1	7	..	..	..	..	1	7
Total	11	1' 42"	26	5' 48"	18	6 9"	21	8' 43"	76	22' 22"

DIVISION.	Total No. of Trains.	Total No. of Engine Failures.	Total Time Lost.	Per cent. of Failures to No. of Trains.
Division A	2,414	11	1 h. 42 m.	.0045
Division B	3,337	26	5 h. 48 m.	.0078
Division C	2,463	18	6 h. 9 m.	.0073
Division D	2,640	21	8 h. 43 m.	.008

TABLE II.

	DIVISIONS.			
	A.	B.	C.	D.
Detentions by signals	2 h. 42 m.	50 h. 3 m.	35 h. 24 m.	23 h. 51 m.
Total time lost other than engine failures and signals	59 h. 51 m.	121 h. 38 m.	63 h. 49 m.	143 h. 36 m.
Total time lost due to all causes	64 h. 15 m.	177 h. 29 m.	105 h. 22 m.	176 h. 10 m.
Total time made up exceeding schedule time.	14 h. 3 m.	107 h. 7 m.	90 h. 3 m.	124 h. .. m.
No. of hot boxes on cars	....	6	4	6
Time lost due to hot boxes on cars	....	1 h. 48 m.	50 m.	53 m.
No. of passenger trains	2,414	3,337	2,463	2,640
Time lost due to hot boxes per passenger train	....	.0323 m.	.0203 m.	.0200 m.

INTERNATIONAL STANDARDS FOR THE ANALYSIS OF IRON AND STEEL.

ORGANIZATION AND WORK OF THE SUB-COMMITTEE.

At the World's Congress of Chemists, in Chicago, last August, following the papers of Professor J. W. Langley, "On the Work of the Committee on International Standards for the Analysis of Iron and Steel," and of Dr. C. B. Dudley, "On the Need of Standard Methods for the Analysis of Iron and Steel, with Some Proposed Standard Methods," was a brief discussion, which resulted in the reference by that body of the whole subject of standard methods for the analysis of iron and steel, to the Committee on International Standards for the Analysis of Iron and Steel. That Committee, it will be remembered, consists of seven chemists, in each of five different countries—namely, England, France, Germany, Sweden and the United States. The American Committee was appointed jointly by the American Society of Civil Engineers and the University of Michigan, with Professor J. W. Langley, Case School of Science, Cleveland, O., as Chairman. The other members of that Committee were: W. P. Barba, Midvale Steel Works, Nicetown, Philadelphia, Pa.; A. A. Blair, 406 Locust Street, Philadelphia, Pa.; Professor Regis Chauvenet, President State School of Mines, Golden, Col.; Professor T. M. Drown, Massachusetts Institute of Technology, Boston, Mass.; Dr. C. B. Dudley, Chemist Pennsylvania Railroad Company, Altoona, Pa., and Porter W. Shimer, Easton, Pa.

Following the reference of the subject to this Committee, it was decided after consultation to appoint a Sub-Committee, to take up the question of standard methods. The Sub-Committee is constituted as follows: W. P. Barba, A. A. Blair, T. M. Drown, Porter W. Shimer and C. B. Dudley, Chairman.

The Sub-Committee held an organizing meeting at the office of A. A. Blair, 406 Locust Street, Philadelphia, on December 13, all the members being present. The object of the meeting was to map out the work. It was agreed as follows:

1. That Mr. Blair should submit a form of circular to go to the iron and steel chemists of the country, asking for a brief outline of the methods which they prefer, and the reasons for all the important points of their methods.

2. That the work of the Committee should comprehend the recommendation of standard methods to be used as the basis of commercial transactions, and when any of these methods could not be used in steel works in daily practice, on account of time required, an alternative rapid method should be recommended, and its limitations defined.

3. That the members of the Committee should draw up each proposed standard method in writing, with some minuteness, and give the reasons for each important point, these written drafts to be sent to the Chairman, to be duplicated, and sent to every member of the Committee. Later, the points agreed upon are to be edited by some one member of the Committee.

4. That only one element should be embraced in a method.

5. That the first method to be taken up should be phosphorus in steel.

6. Mr. Barba offered to furnish to each member of the Committee, a suitable quantity, not less than a pound or so, of borings of three (3) different kinds of steel—namely, one of from 0.01 to 0.02 phosphorus, carbon about 0.90, and silicon about 0.40; another with phosphorus not far from 0.06, carbon 0.50 to 0.60, silicon 0.25 to 0.30, and arsenic 0.15 per cent. The above two, to be crucible steel. Another sample of open-hearth steel of carbon, 0.90 to 1.05; phosphorus, 0.02 to 0.04; manganese, 0.30 to 0.40; silicon, 0.20 to 0.25; sulphur, 0.02 to 0.04; and copper anywhere below 0.10.

7. Dr. Dudley offered to furnish to each member of the Committee a like amount of borings from a sample of Bessemer steel of from 0.10 to 0.12 phosphorus, carbon about 0.50, manganese 0.80 to 1.00, silicon 0.02 to 0.05, sulphur 0.07 to 0.10, and copper from 0.07 to 0.10. These samples of steel to be used in deciding various questions that may come up in regard to proposed methods.

A very earnest feeling was manifested at the meeting of the Sub-Committee, and the outlook for some good work is apparently very favorable.

APPROVED: CHARLES B. DUDLEY,
J. W. LANGLEY, *Chairman Sub-Committee.*
Chairman Committee on International Standard.

FIRE AT PURDUE UNIVERSITY.

The President and Director of the Engineering Laboratory of Purdue University have issued a circular to its "friends," in which they announce the destruction by fire of the new Engineering Laboratory on the night of January 23—four days after its dedication. In the announcement it is said:

"The fire originated in the boiler-room and spread with great rapidity. Its progress could not be checked until the larger part of a fine building had been destroyed. Three laboratory rooms were burned: the machine-room with its 20 lathes, its planers, shapers, drill presses, milling machines, and its large supply of small tools; the forge-room with its

32 power forges; and the laboratory for advanced work, which contains Purdue's now famous locomotive *Schenectady*, a triple-expansion Corliss engine, and much other apparatus designed for work in steam engineering, hydraulics, and strength of materials. Nothing in these rooms escaped the fire. Not only was all the apparatus lost, but also a large amount of experimental data. The main portion of the building was also consumed. This contained three stories, 50 ft. × 150 ft. It was occupied by drawing-rooms, recitation and lecture rooms,

RIEHLE MEASURING AND PER CENT. GAUGE.

instrument-rooms, offices and a mechanical museum. Some of the furniture and apparatus in these rooms was carried out before the fire took possession, but, as already stated, this part of the building was entirely burned.

"The only portion still standing comprises the wood-room and foundry. These rooms were not damaged except by the temporary removal of the more portable portion of their equipment.

"The incidental losses by the fire are considerable. Members of the faculty have lost books, papers and data; students, their instruments; and many manufacturers in every part of the country, who by gifts or liberal discounts had co-operated in the equipment of the building, have lost their representation there.

"Such a laboratory as the one burned is the result of many influences, not among the least of these being the suggestions of professional friends and the material assistance of those who, as manufacturers and builders, are helping to advance the standard of engineering construction. We gratefully acknowledge the assistance thus rendered, and hope that our success in the past may warrant a continuation of the interest that has heretofore been accorded us."

A course of lectures on the protection of buildings from fire would seem to be in order at this and perhaps at other similar institutions.

RIEHLE MEASURING AND PER CENT. GAUGE.

We present to our readers in this issue an illustration of the Riehle measuring and per cent. gauge. An ingenious apparatus of this kind will be readily appreciated by those in charge of testing departments, where the percentage of elongation on tensile specimens of metal is required. It has eight notches 1 in. apart, and is 12 in. long, the 4 in. beyond the notches being laid off and graduated to show the elongation in per cent. without other measuring or figuring.

On the under side is a shoulder running with the length of the scale, so that the lines scribed to show the inches will be across the test piece, at right angles to its axis. The scale is used either with the lines scribed with this instrument, or with pieces laid off with the double-pointed center punch. It is a great time saver, and its use also eliminates the possibility of error in measuring extensions and figuring the percentage of elongation. For pieces laid off in lengths other than 8 in. the percentage scale is in proportion: Thus in 4-in. measurements the reading is doubled, and in 2-in. measurements it is quadrupled. It is made only by Riehle Brothers' Testing Machine Company, Philadelphia, Pa. It is in use by several testing bureaus, among others the Robert W. Hunt & Co. Bureau of Inspection, Tests and Consultation, Chicago; also at the Testing Department of the Illinois Steel Works, North Chicago Works, and the Department of Physical Tests of Riehle Brothers' Testing Machine Company, Philadelphia.

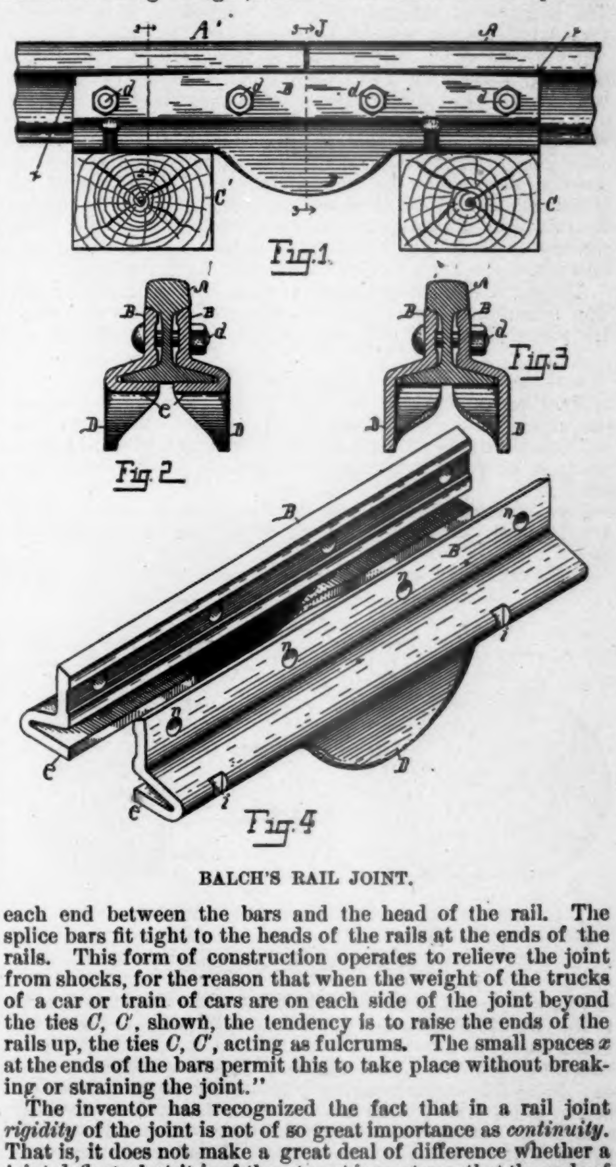
Recent Patents.

BALCH'S RAIL JOINT.

The engravings show, fig. 1, a side view; fig. 2, a transverse section on the line 2 2, of fig. 1, looking toward the right; fig. 3, a similar section on the line 3 3 at the middle of the splice bars; and fig. 4 is a perspective view of the bars with the rails omitted. The inventor describes this invention as follows:

"The splice bars *B* are extended below the base of the rails. The portions *e*, figs. 2 and 4, at the ends of the bars are folded tight against the under side of the base of the rails. The portions *e* so folded rest on the ties *C*, *C'* under the rail, and form a chair for the rail. The middle portions *D* of the splice bars *B*, instead of being folded tight against the under side of the base of the rail, are projected down in a vertical position at the edge of the base and form the trusses *D*, one on either side of the rail. The metal between the truss *D* and the horizontal portion *e* of each bar is left intact. Of course it will be somewhat stretched by the bending of the plate, of which the bar is composed, to the desired form. The metal could be divided between the two parts *D* and *e* and still embody my invention. The bars *B* are bolted to the rails by the bolts *d*, which pass through the bars *B* at and through the web of the rails in the usual manner. Notches are cut in the bars at *i*, fig. 4, to receive the spikes that hold the whole securely to the ties. Bolts could also be inserted through the trusses *D* to hold the bars, but they are not necessary, and I prefer not to use them.

"The upper part of the splice bars *B* are in the usual form of angle bars for that purpose, except that the upper edge, instead of being straight, is curved to leave a small space at



BALCH'S RAIL JOINT.

each end between the bars and the head of the rail. The splice bars fit tight to the heads of the rails at the ends of the rails. This form of construction operates to relieve the joint from shocks, for the reason that when the weight of the trucks of a car or train of cars are on each side of the joint beyond the ties *C*, *C'*, shown, the tendency is to raise the ends of the rails up, the ties *C*, *C'*, acting as fulcrums. The small spaces *x* at the ends of the bars permit this to take place without breaking or straining the joint."

The inventor has recognized the fact that in a rail joint *rigidity* of the joint is not of so great importance as *continuity*. That is, it does not make a great deal of difference whether a joint deflects, but it is of the utmost importance that the ends of the two rails should be held so that their positions will always conform to each other, and the tops of the two rails be in a continuous line. It does not matter much whether this is an absolutely straight line or is slightly curved, but it is of the greatest importance that the end of one rail should not project above that of the other. Thus, if a car or engine is moving toward the left, if when it comes to *A*, fig. 1, the tie *C* and the rail *A* should be depressed, if the latter carries the end of *A'* with it, so that when the wheel gets to the joint at *J* the tops of the two rails are flush, the wheel will roll over the joint and there will

be very little shock or concussion, even though both rails are deflected at the joint. If, however, the rail A is depressed independently of A', and when the wheel reaches the end of A' it projects one-sixteenth of an inch or more above A, there will be a shock proportionate to the difference in height of the ends of the two rails. A similar result would follow if the tie C was rigidly supported and C' was unsupported, and would be depressed when the end of the rail A' was loaded. In that case the wheel would drop from an elevation at the end J of the rail A and fall on A', whatever distance the tie C' could be depressed, and a concussion and battering of the end of the rail A' would result. If, however, the ends of the two rails are securely held, so that their top surfaces will always be exactly flush with each other, then, no matter whether either or both are deflected, a smooth joint will be maintained nevertheless.

It may be added that absolute rigidity in track is impossible. Of course, with very heavy rails and plenty of ballast and thoroughly good maintenance there will be more rigidity than is possible with light rails, little or no ballast, and neglect of repairs. The deflection of rails must, however, be recognized. There will always be deflection, and it should be provided for. The inventor of this rail joint has, therefore, it is thought very wisely, made provision for this, and has made the top edges of his splice bars curved, so that they fit tight to the rails only at their ends, and there is a little space or clearance between the ends of the bars and the under side of the heads of the rails. This allows deflection of the rails to take place without undue strain on the bars. The bars form a bridge extending from one tie to the other, which is made as rigid as possible to support the ends of the rails, but if one of the abutments should be depressed the consequent deflection of the rails does not bring an undue strain on the bridge. The rigidity of the bridge, it will be seen, is obtained by the form into which the lower flanges e e are bent, as shown at D.

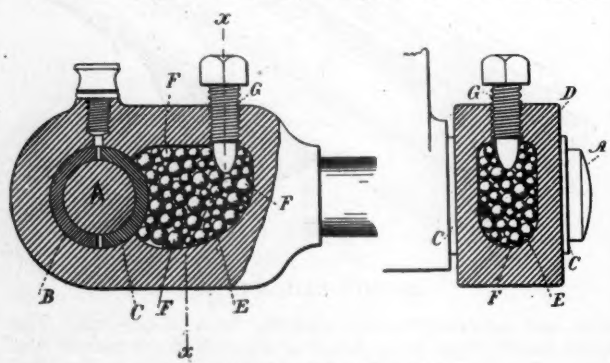
Altogether this invention seems to be a very promising one. The inventor is Mr. Frank C. Balch, of Kalamazoo, Mich. His patent is No. 509,422, and is dated November 28, 1893.

HUNT'S JOURNAL BEARING.

Mr. Charles W. Hunt, of New York, has recently patented the ingenious device shown in the engravings for "setting up" the bearings of journals, such as crank-pins and other journals where a "stub-end" or "strap-end" is ordinarily provided.

Fig. 1 is a longitudinal and fig. 2 a tranverse section of this arrangement, which is described as follows in the specification:

"The crank pin or shaft at A is provided with the brasses



HUNT'S JOURNAL BEARING.

or boxes B C, and these are held in any suitable support, such as the end of the connecting-rod D, and adjacent to one of the boxes there is a cavity E into which are inserted balls or spheres F, preferably of hard steel. A series of balls are used of various diameters introduced into the cavity adjoining the box or brass that is to be set up, and a screw G is provided, sometimes having a tapering point, that passes into the hole through which the balls may be introduced, and such screw pressing upon the balls causes them to come into intimate association and bearing one upon the other and also upon the box that is to be set up, and these balls slide one upon the other as pressed upon by the screw, so as to exert the necessary force against the whole of the outer surface of the box or bearing, to press the same to its position. By making use of balls or spheres of different sizes I am enabled to obtain a substantially fluid condition, so that the screw G when it is pressed upon the spheres causes one to roll upon another, and a pressure to be exerted around all sides of the cavity E and against one side of the box C, so as to press the same with the desired force against the crank-pin or shaft A. It is preferable to make the opening for the screw G sufficiently large for the balls to pass freely through the same and into the cavity, and to introduce lubricating material with the balls for the two-fold purpose of preventing rust and for causing the balls to slide or roll freely one upon the other under the action of the screw G, as the same may be set up from time to time; and it will be observed that there is no hammering or loosening action exerted upon the screw G. Hence the same is not liable to turn or to become loose, and when the parts have come to a proper bearing any wear or looseness can be taken up with great facility by a slight turn of the screw G.

"In practice," the inventor says, "that when balls of the same size are used they pile with regularity similar to pyramids and wedge into the cavity, and there is not a tendency to press in any direction; but when the balls are of different sizes they will not pile or pack, but slide and move one on the other similar to a liquid, and hence press in any direction within the cavity when acted on by the screw."

The invention is a very ingenious one, and should practical experience confirm the promise of its usefulness, it may effect an entire change in the construction of strap ends, which have held their own for more than a century.

The inventor is Mr. Charles W. Hunt, the well-known manufacturer of hoisting and conveying machinery, of 45 Broadway, New York. The number of his patent is 512,826, and the date is January 16, 1894.

SALVETER'S METAL DRAFT-SILL FOR CARS.

"The main object of this invention," it is said in the specification, "is to provide a draft-sill that is light and compact, and is at the same time capable of withstanding the severe shocks and strains to which this part of cars is commonly subjected. For this purpose the sill is made of metal instead of wood, and such portions of the sill as would bear little or no portion of the strains is cut away, and certain flanges and other appendages are provided, preferably cast integral with the sill and calculated to greatly increase the strength without adding materially to the weight and bulk thereof."

The general construction which is proposed will be understood from the engravings without other description. Fig. 1 is a longitudinal vertical section of the draw-gear of a car drawn on the line 1—1 of fig. 2, and shows one of the metal draw-sills as seen from the inner side. Fig. 2 is a transverse vertical section on the plane of line 2—2 of fig. 1, looking from the left in fig. 1. Fig. 3 is a plan view of a pair of the draft-sills, showing one of them in section, this section being on the plane of line 3—3 of fig. 1. Fig. 4 is a side elevation of one of the sills, as seen from its outer side.

While the general construction of these draw-sills will be apparent from the engravings, the inventor's description of some of the special features will be quoted. The specification says:

"Extending horizontally between the upper portion of the front and rear draw-lugs 26 and 27, and projecting at right angles from the inner surface of each sill near its upper edge, is an offset or flange 36, along the under surface of which are moved the upper edges of the respective draw-followers 30 and 31 when the car is drawn forward or backed, and the draw-spring is depressed, these flanges 36 serving to confine said draw-followers and prevent their rising upward out of place. The flange or offset 36 is cast integral with the sill, both for simplicity and greater strength.

"Extending horizontally between the lower portion of the front and rear draw-lugs, and corresponding to the flanges 36 just described, are the removable tie-plates 37, which, after the draw-head, draw-spring, and draw followers have been inserted in their proper places, are placed against the lower surface of the draw-lugs and securely held to said lugs by bolts 38 passing through vertical perforations (fig. 3) in the front and rear draw-lugs 26 and 27. These tie-plates hold the draw-followers and co-operating parts in place, and prevent the same from dropping or being forced out of position downwardly.

"It will be observed that the strain on the draft-sill will ordinarily be greatest in the vicinity of the draw-followers, and will diminish toward the rear portion of the draft-sill, which rear portion is therefore made of decreasing height. A further saving of metal and lightness of the sill are secured by cutting away the middle portions of the same in the spaces between the columns 17 before described, as clearly shown in figs. 1 and 4. For a like purpose a considerable part of the middle portion of the columns 17 may be cut away, as clearly shown in figs. 2 and 4.

"The front ends (or ends furthest to the left in fig. 1) of the draft-sill 13 are preferably turned slightly inward, approach-

ing more closely toward each other and toward the draw-head than the remaining portions of the sill.

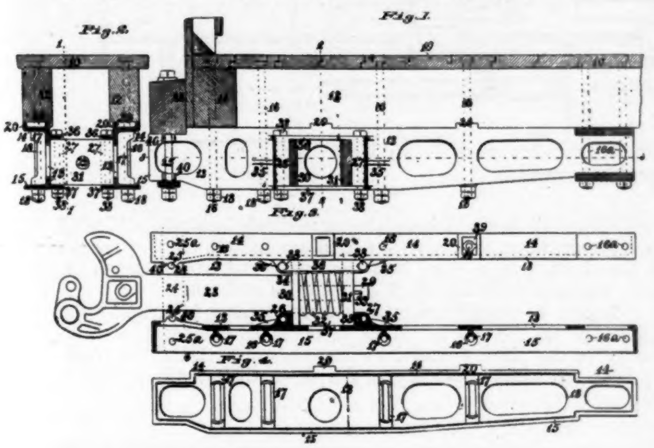
"Extending vertically across the inner surface of the sills near the front end just described I provide, preferably cast integral with the sills, raised ribs 40, having semi-cylindrical vertical grooves in which rest the bolts 25 which secure together the deadwood 23, carrier-iron 24, and front ends of the sills, as above described. It will be evident that the space between the sills at the front end is, in this manner, greatly contracted, the object of which construction is to leave only a very limited play for the draw-head, thereby guarding against breakage of the reduced part or tail-pin 29 and the draw-followers 30 and 31, the shock of a sideward thrust of the draw-head being spent on and resisted mainly by the bolts 25 just described."

The inventor does not say in his specification whether he contemplates making these draw-sills of cast iron or cast steel, but obviously they must be made either of the one metal or the other.

The patentee is the well-known car-builder, Theodore C. Salveter, of St. Louis. The number of his patent is 512,329, and the date is January 9, 1894.

LOCOMOTIVE ENGINE.

There is perhaps no problem in connection with locomotive engineering, if we except the valve-gearing on which so much ingenuity has been exercised, as on that of providing a flexible driving-wheel base. By that is meant an arrangement of driving-wheels which will permit them to adjust themselves



SALVETER'S METAL DRAFT-SILL.

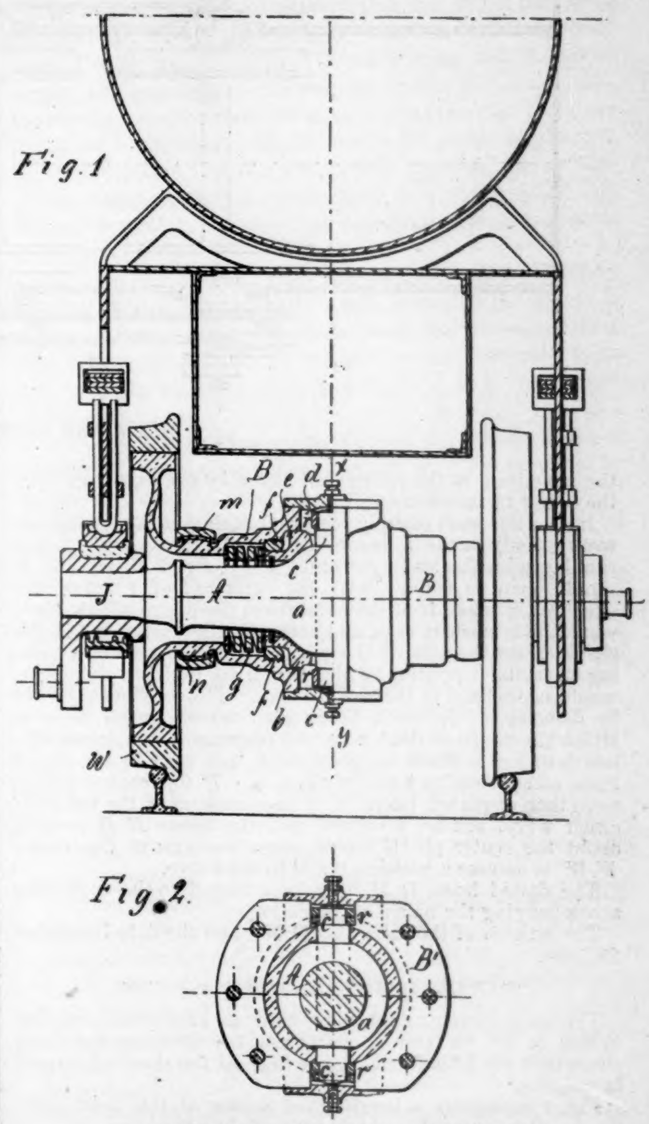
to the sinuosities of curves and assume radial positions in relation thereto. A very large number of such inventions have been proposed of varying degrees of practicability and impracticability—chiefly the latter. Messrs. Richard Klein and Robert Lindner, of Chemnitz, Germany, have recently taken out an American patent for an ingenious arrangement, which is not without some promise of success.

Fig. 1 is a transverse section on the lines *t c* and *v w* of fig. 3, which is a plan of the running gear of a six-wheeled coupled locomotive. Fig. 2 is a transverse section in the middle of the leading axle on the line *x y* of fig. 1.

The invention relates to what is called in the specifications "displaceable" axles. In the illustrations herewith only one such displaceable axle—the leading one—is shown, but the inventors describe an engine in which both the front and trailing axles are arranged in this way, and the intermediate axles also have some capacity for lateral movement.

The displaceable axle consists of what the inventors call an "inner core," which in reality is a shaft *A* which is attached to the frames *F F* by journals *J J* of the ordinary type. This shaft is driven by cranks and coupling-rods in the usual way. The wheel centers, which are attached to this shaft, are each made with a hollow sleeve, *B*, which extend from the wheels to the longitudinal center line of the engine, and are then bolted together by suitable flanges *B'*, shown clearly in figs. 2 and 3. The central shaft or "core" is provided, at its center, with a spherical or "ball" bearing *a*, which is journaled in a corresponding spherical bearing *b*, fig. 1, made in two parts and secured to the sleeve *B*. The extremities *c c* of the bolt have bearings *r r*, which are enclosed in slots *d* in such a manner that they have a certain play transversely to the track, and may also turn around the axis of the bolt, but have no play at all, or but very little, in the longitudinal direction of the track or circumferentially to the shaft. It will be understood, therefore, that while the sleeve *B* may be displaced laterally on the shaft or axle proper *A*, and may assume a position at an angle to *A*, yet in no case will the axle or shaft *A* be able to rotate without the sleeve *B*, but both parts will always rotate together. Rings *f f* are inserted within the sleeve and are firmly secured to the same. These rings enclose and hold part of the bearings *b*, which can move in the sleeve a certain distance transversely to the engine or in the direction of the axis of the shaft or axle *A*. The rings *f* also limit the transverse displacement or movement of *b* in the sleeve. A small annular space *e* is left between the rings *f* and bearing *b*, in order to allow for the movement of the latter. Two coiled springs *g*, bearing with one end against a shoulder of the sleeve *B*, and with the other end against the ring *f* and the bearing *b*, constantly tend to bring the sleeve *B* and the wheels *W* into the normal position shown in fig. 1.

The sleeve *B* has two collars or journals *n*, the surfaces of which are also turned to a spherical form. To these rings or



KLEIN AND LINDNER'S LOCOMOTIVE.

straps *m* are loosely fitted, and to the rings connecting-rods *m'*, fig. 3, are secured, which is jointed to a bolt l^1. This bolt is connected to a coiled spring *h*.

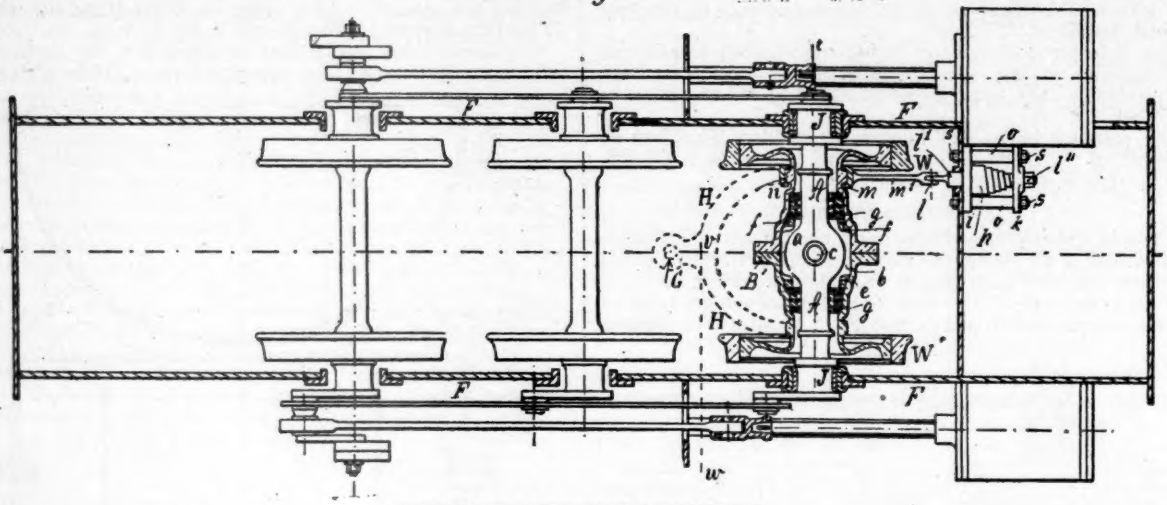
In their specification the inventors describe the action of their engine as follows:

"When the engine enters a curve, the core *A* will remain perpendicular to the longitudinal walls of the frame *F*. The sleeve *B*, however, will assume such a position that its axis will be normal to the rails—*i.e.*, directed toward the center of the curve. It will be obvious that this adjustment of the sleeve *B* carrying the wheels will be automatic, the rails acting as guides for the flanges of the wheels. At the same time the sleeve *B* and core *A* will be displaced somewhat in relation to each other, transversely to the track. One of the springs *g* will be compressed by this movement, and the spring *h* will likewise be compressed. When the track is

again in a straight line, the spring g, which has been compressed, will expand and bring the sleeve B back to its central position, as shown in fig. 3. The spring h will likewise expand and thereby restore the sleeve B to the position in which its axis coincides with that of the core A. It will be obvious that the running of the engine through sharp curves will be considerably facilitated by the automatic adjustment of the wheels tangentially to the rails.

"Another advantage of our improved construction is that each of the wheels connected to one sleeve B carries exactly the same load, as the entire load borne by one axle rests upon the center of the sleeve."

Fig. 3



KLEIN AND LINDNER'S LOCOMOTIVE.

It does not seem entirely certain though that the engine will work exactly as the inventors expect. If, for example, it was running with the leading wheels W W', fig. 3, ahead, and W should come in contact with the outer rail of a curve, the effect of the pressure of the rail against the flange of this wheel would be to push it back and compress the spring h. If this should occur the axis of the wheels W W', instead of assuming an inclined position, which would be radial to the curve, would be inclined in the reverse way. This obviously would be dangerous. A much better plan would appear to be to attach the straps or rings n on the bearings m to a frame similar to that of a Bissel or pony truck, indicated by the dotted lines, and pivoted to a center pin at G. If the leading wheels were then displaced laterally by the pressure of the flange of either wheel against a curved rail, the frame H H moving about the center pin G would cause the axis of the wheels W W' to assume a position radial to the curve.

The dotted lines, H H, have been added to the engraving accompanying the patent specification.

The number of the patent is 511,531, and the date December 26, 1893.

COLE AND GRIEVES DRAW-GEAR FOR CARS.

The accompanying engravings show an analogous invention to that of Mr. Salveter's. Its object, the inventors say, is to strengthen the framework of cars to resist the shock of impact in coupling.

Fig. 1 represents a longitudinal section of this draw-gear, fig. 2 a plan, and fig. 3 an end view of the block 5.

"In the form of construction designed by the inventors of this arrangement, 11—11, fig. 2, represent the usual center sills commonly used on cars. 10 is a central timber not usually used in constructing freight cars of this class. It stands between the timbers 11—11, to which it is bolted by a series of transverse bolts. The end of the timber 10 abuts against the end sill 9 in its center and between the truss-rods 7—7. The under side of the timber 10 is notched at 14—14, fig. 1. 1—1 are the drawbar timbers of the car; 2 the coupling-head and bumper; 3 the bumper-spring; 4 the bumper follower-plate, upon which the bumper spring rests.

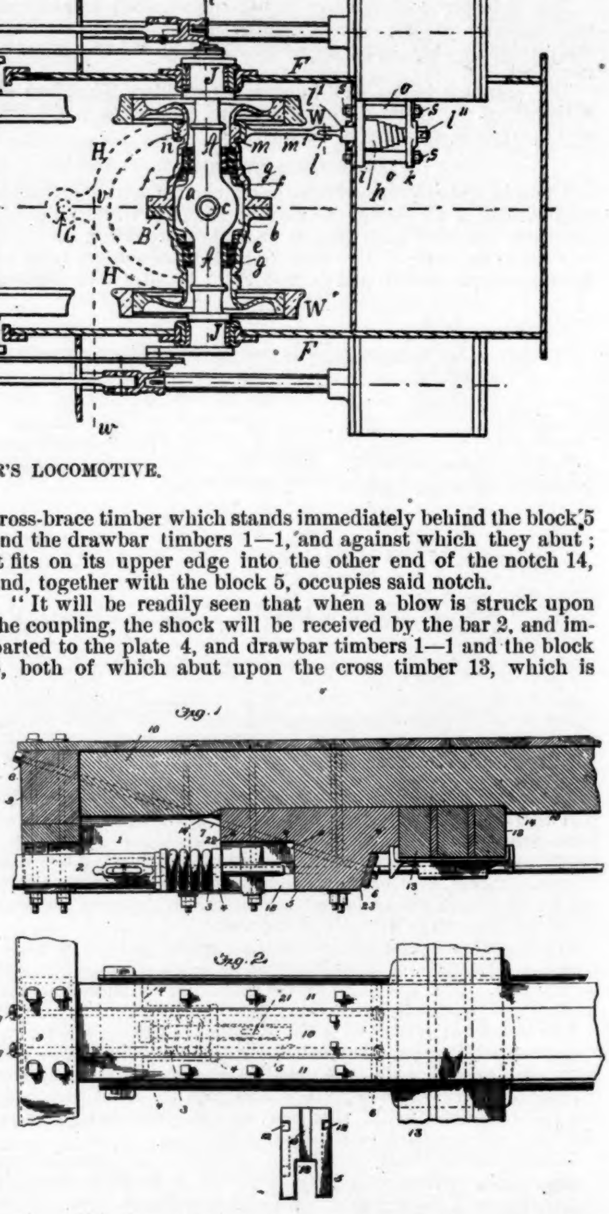
"5 is a filling block which stands between the rear ends of the drawbar timbers 1—1, to which it is bolted by horizontal bolts 22—22 passing through said timbers and block. The rear ends of both drawbar timbers and block 5 are made of the same shape, and at the lower corner are provided with a notch having an inclined surface 23.

"6 is a washer plate bearing against the inclined notch 23 and extending across the rear ends of both drawbar timbers and block 5.

"7—7 are two truss-rods which pass through the plate or washer 6, through the grooves in the sides of the block 5, and through slots in the sides of the central timber 10, and through the end sill 9, and washer 8. Upon its extremity a nut is screwed which bears upon the washer 8.

"The block 5 extends slightly above the drawbar timbers 1—1 which fits into the forward end of said notch. 13 is a cross-brace timber which stands immediately behind the block 5 and the drawbar timbers 1—1, and against which they abut; it fits on its upper edge into the other end of the notch 14, and, together with the block 5, occupies said notch.

"It will be readily seen that when a blow is struck upon the coupling, the shock will be received by the bar 2, and imparted to the plate 4, and drawbar timbers 1—1 and the block 5, both of which abut upon the cross timber 13, which is



COLE AND GRIEVES' DRAW-GEAR.

notched into the timber 10. Timber 10 being bolted by a series of horizontal bolts to the frame timbers of the car-body, the strain put upon the drawbar timbers 1—1 and the block 5 will also be imparted to the truss-rods 7—7, through the plate 6, and by said bolts to the end sill 9, and to the frame of the car. It will thus be seen that all shocks upon the couplings will be equally distributed throughout the car frame, and the maximum strength secured."

The inventors are Francis J. Cole, Mechanical Engineer, and Edward G. Grieves, Master Car-Builder of the Baltimore & Ohio Railroad, both of Baltimore. Their patent is numbered 511,588, and its date is December 26, 1893.